

I. Blackwell

# *Mechanick Dialling;*

*Or, the* *Smith*  
*New Art of Shadows:*

*Freed from the many*  
*Obscurities, Superfluities and Errors*  
*Of Former Writers upon this Subject.*

*The whole laid down after so plain a Method, that any Person*  
*(tho' a Stranger to the Art)*

*With a Pair of COMPASSES and Common RULER only,*  
*May make a Dial upon any Plane for any Place in the WORLD, as*  
*well as those who have attained to the greatest Knowledge*  
*and Perfection in the Mathematics.*

*Illustrated with many Copper Plates,*

And

*Examples of Dials for London, Exeter, Bristol, Worcester, Oxford, Cambridge, Norwich, Lincoln, Chester, Liverpool, York, Newcastle upon Tyne, Durham, Edinburgh, Dublin, &c.*

To which are added,

1. A Collection of above 300 *Mottos* in *Latin* and *English*.
2. A *New* and *Correct* Alphabetical Table of the most eminent *Cities* and *Towns*, in the whole *World*; shewing the *Elevation of the Pole*, and the *Difference of their Meridian* from *London*.
3. The best and most approved Methods of Painting *Sun-Dials*.

A *Work* not only useful for *Artificers*, but very *entertaining* for *Gentlemen*, and those *Students* at the *Universities*, that would understand *Dialling*, without the *Fatigue* of going through a *Course of Mathematics*.

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*A NEW Edition: not only very much improved by the Addition of the NEW Star-Dial, &c. but it is the only Book upon the Subject that has been adapted to the NEW STYLE.*

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By Mr. CHARLES LEADBETTER.

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L O N D O N:

Printed for E. WICKSTEED, in *Warwick-Court, Warwick-Lane,*  
*Newgate-Street, 1756.*





AUTHOR *to the* READER.

*SEEING the Business of Dialling, if Mechanically considered, is of itself a Thing so natural and easy, one would wonder, after so much learned Bustle as the Mathematicians have made about it, that they should have more perplexed and obscured than promoted the Knowledge of that useful and entertaining Art amongst the Generality of Mankind.*

*The different Ways, in which these Gentlemen have hitherto chose the World should see that useful Subject handled, would certainly have been right and proper, and liable to no Exception, if all Men were Mathematicians: But how few are such? And therefore their having treated of Dialling in a Geometrical, Instrumental or Arithmetical Method, I am sure cannot possibly be of any Use or Signification to such as know nothing at all of those Sciences or the Doctrine of the Sphere.*

*Certainly, there are two very different Ends of writing Books, which treat of any Art or Science; the one is to advance the Art or Science itself, and the other to instruct Learners.*

*Now, with respect to the Former, the Extent and Capaciousness of the Subject is chiefly to be regarded; and nothing is to be omitted which properly falls within the Compass of the Art or Science treated of; but with respect to the latter, the Capacities of the Learners are principally to be considered, and Notice is to be taken, not of whatever may be known or done by the Art or Science treated*

*of, but only of what is most useful, and withal most easy to be known.*

*The most proper and rational Method, therefore, to make any one Master of any Art or Science, is to introduce it to him after the most plain, familiar and natural Method, and to teach him at first only so much of the Art as is really useful in common Life, and withal most easy to be understood; and when he has gone through, and is become Master of what is most useful and easy, he will be enabled with more Ease to conquer the more difficult Parts of it, and to pursue the Study of it after a more learned Manner, if his own Inclinations or Profession shall incline him so to do.*

*Upon these Considerations, and with this View it was that I drew up this Treatise of Mechanick Dialling, because of all those who have hitherto treated upon this Subject in the English Tongue for the Instruction of Learners, not one of them seems to me to have thoroughly considered, what I have now premised.*

*By the Method I have observed in this Treatise, the Length and Dryness of the Study of Dialling (which has discouraged many) is quite removed; and it is now rendered not only very useful, but perfectly easy and entertaining: And I think without Vanity I may venture to affirm, that by the Help of this Book only, the Learner may obtain a competent Knowledge in Dialling, in much less Time, and with much less Trouble, than he can by the Assistance of any other, or indeed all the Treatises which have yet appeared in English upon this Subject: where he will either find the easy and useful, and the difficult and useless Elements of this Art promiscuously and injudiciously exhibited  
and*

*The Author to the Reader.*

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and taught together; or else the Subject treated of after such a Manner as can never be comprehended by any one that does not understand some of the abstrusest Branches of the Mathematics.\* But

It is high Time that I should now proceed to give the Reader the Particulars of what he may expect to meet with in the following Treatise.

In the first Place, he is made Master of those few Geometrical Problems, which may be of Service to him in Mechanick Dialling.

Secondly, I have taught him not only the Use of the Quadrant and Trigon, but also how to make those universal Instruments, which for their Simplicity, and the great Use they are of in Dialling are never enough to be valued. I have likewise taught him not only the Use of, but also how to make Dialling Scales, and this is not to be met with in any other Treatise extant upon this Subject.

Thirdly, I have given him such plain and ample Directions, that it will be impossible for him to miscarry in making of a Dial for any Place in the World, whether the Dial be Equinoctial, Horizontal, Erect, Declining, Reclining or Inclining.

Fourthly, to these I have added plain and easy Directions for making of Reflective, Refractive and Globe Dials.

I have likewise taught the Reader how to make a Cross Dial, and in this, on account of its Novelty, I have been very full and particular, not only in shewing him after what manner it must be made, but in having the several necessary Views or Positions of it engraved on Copper. I was tempted to be thus particular, by reason I never yet saw

\* Such as Geometry, Astronomy, &c.



or heard that there was any other Dial of that Sort in England, besides that which I have mentioned in this Treatise. And I have also in this new Edition given a Copper-Plate of, as well as Directions for making the new invented STAR-DIAL.

Fifthly, I have furnished the Reader with the following very useful and accurate Tables, all adapted to the new Stile.

1. *A Table of the Sun's Declination exactly calculated for the Year 1754, and which (for the Use of Dialling) will serve for this Age without any sensible Error.*

2. *An exact Table of the Equation of Time for the Regulating of Clocks and Watches by a Sun-Dial.*

3. *A Table for the Converting of Hours and Minutes of Time into Degrees and Minutes of the Equinoctial, and e contra.*

4. *A Table for drawing the Hour Lines upon all Horizontal, &c. Dials, from the Equinoctial to the Poles.*

5. *A Table of the Three Requisites in Dialling, shewing the Substile's Distance from the 12 a-clock Hour Line; the Stile's Height, and the Inclination of Meridians answering to the several Degrees of the Declination of your Plane.*

6. *A Table shewing the Sun's Altitude for every Hour and Quarter of the Day, at his Entrance into the 12 Signs of the Zodiack.*

Sixthly, I have given a plain and familiar Description of the Sphere, for the Sake of such as are inclined to have a true Notion of such Circles in the Heavens, as are frequently mentioned in this and other Books of Dialling.

Seventhly, In Chap. XXIII. is a Collection of  
Mottos

*Mottos for Dials in Latin and English, suitable to almost all Places where Dials may be fixed.*

*Eighthly, That nothing might be wanting to render this Work compleat, I have added a new and correct Alphabetical Table of the most eminent Cities, Towns, &c. in the whole World, shewing at each Place the Elevation of the Pole, and Difference of their Meridian from London, and this Table may be depended upon to be the best that is extant, because I have spared neither Time nor Pains to correct as many as I could from celestial Observations.*

*Ninthly, In Chap. XXVI. I have been very full and particular concerning the Manner of making and painting of Dial Planes, and also concerning the preparing the different Colours and Oils proper for that Purpose; and in this I hope to merit the Approbation of those who live in the Country, and cannot upon all Occasions have the Assistance of a professed Painter.*

*And I have also added Chap. XXVII. concerning Painting Houses, &c. being thoroughly convinced that all those Country Gentlemen, and others, who are inclined to be good Husbands, will think it very well worth their Perusal.*

*Lastly, Though it may appear a little foreign to my present Purpose, yet for the Entertainment of the curious, I have shewn (in Chap. XXV.) how naturally the two Hands of a Watch or Clock represent the Motions of the Sun and Moon.*

*And now wishing my Reader as much Benefit from the Perusal of this Treatise, as I have had Pleasure in composing of it, I remain his faithful Friend whilst*

CHARLES LEADBETTER.

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*Many Years a Gauger in the Royal Revenue of Excise.*

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17 MA 67

# Of Mechanick Dialling.

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## CHAP. I. *Treats of Things necessary to be known by the Mechanic Dial-Maker.*

**D**IALLING originally is a *mathematical Science*, attained by the philosophical Contemplation of the Motion of *the Sun*, the Motion of *the Shadow*, the Constitution of the *Sphere*, the Situation of *Planes*, and the Consideration of *Lines*.

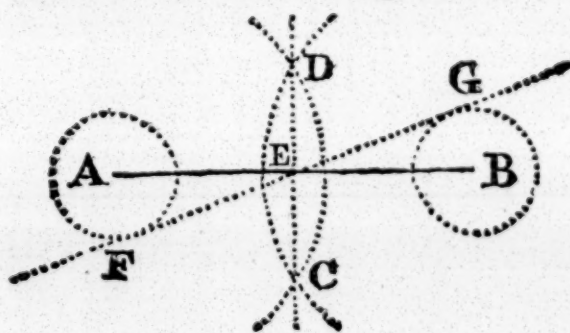
**EXPLANATION.** The *Motion* of the *Sun* is regular, it moving equal *Space* in equal *Time*; but the *Motion* of the *Shadow* irregular in all Parts of the Earth, unless under the two *Poles*, and that more or less, according to the Constitution of the *Sphere*, and Situation of the *Plane*: And therefore *scientific* Dialists, by the geometric Consideration of *Lines*, have found out Rules to mark out the *irregular* Motion of the *Shadow* in all *Latitudes*, and on all *Planes*, to comply with the *regular* Motion of the *Sun*.

But though we may justly account *Dialling* originally a *Science*, yet such hath been the Generosity of many of its studious Contemplators, that they have communicated their acquired Rules, whereby it is now become, to many of the Ingenious, no more difficult than an *Art*, and, by many late Authors, so intituled; nay more, by Means of this small Treatise, it will scarce be accounted more than a *manual Operation*; for though the Authors I have met with seem to presuppose their Reader to understand *Geometry*, and the *projecting of the Sphere* already, or else endeavour in their Works to make him understand them, as if they were absolutely necessary to

be known by every one that would make a Dial, when as in Truth, the contemplative Pains of others aforesaid considered, they are not; but, indeed, are only useful to those that would know *the Reason of Dialling*. Thus they not only discourage young Beginners, but also disappoint many Gentlemen and others, that would willingly either make them themselves, or set their Workmen about them, if they knew how to make them. The following Pages I have therefore composed, for the Help of those who understand neither the *Projection of the Sphere*, or *geometrical Operations*.

**P R O B. I.** *To divide a right Line given (as A B) into two equal Parts.*

Open your Compasses to any Extent *more than half* the *Length* of the Line A B; set one Foot in A, and describe the *Arch* D C, then, with the *same Extent* of the Compasses, set one Foot at B, and



describe the *Arch* D C on the other Side; where these two *Arches cross* each other, lay a Ruler, and draw the *right Line* D C, and it will divide the

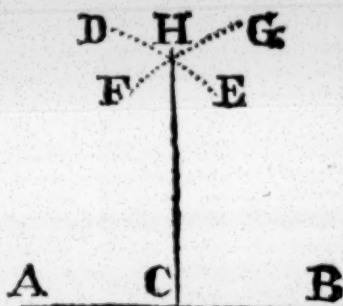
right Line given in E, the *Middle* thereof. Or the same given right Line may be divided into *two equal Parts*, by setting one Foot of the Compasses on the *End* of the Line at A, and there describe the dotted Circle, and then, with the *same Extent* of the Compasses, draw the *other* dotted Circle at B; lastly, draw the right Line F G, and it will divide the given right Line A B in E, as before. **P R O B.**



PROB. II. *To erect or raise a Perpendicular, on the Middle of a given right Line.*

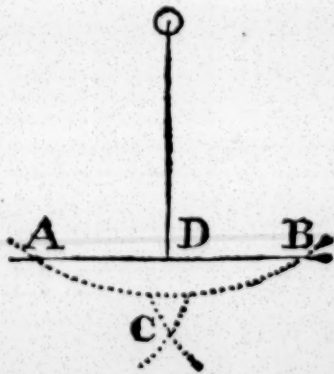
N. B. *One Line is said to be perpendicular to another, when it cuts it at right Angles, that is, makes a true Square.*

On the *End* of the given Line at A, set *one Foot* of the Compasses, and open the *other* to *any Extent*, more than *half* the *Length* of the Line, and describe the Arch DE; with the *same Extent* set *one Foot* of the Compasses at B, and draw the Arch FG; lay a Ruler to C, the *Middle* of the given Line, and to the *Crossing* of the two *Arches*, and draw CH, which will be *perpendicular* to AB, as was required.



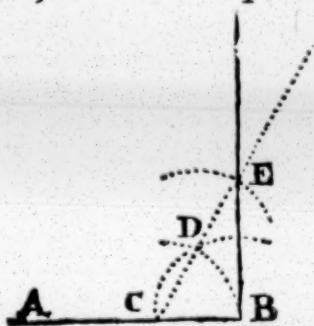
PROB. III. *To let fall a Perpendicular, as  $\odot$  D upon a right Line, from a given Point above.*

Let the *Point above* be  $\odot$ , and the given right Line AB; set *one Foot* of your Compasses in  $\odot$ , and extend the other Foot to A, and describe the Arch AB; set *one Foot* of the Compasses in A, where the Arch cuts the given Line, and draw an Arch at C, with the *same Extent*; then set *one Foot* in B, *viz.* where the Arch cuts the Line, and draw another little Arch at C; lay a Ruler to the given Point  $\odot$ , and to the *Crossing* of the two little Arches at C, and draw the Line  $\odot$  D, so it will be at right Angles to AB, as was required.



PROB. IV. To erect a Perpendicular at the End of a given Line.

Let the given right Line be A B, and from the End B, let it be required to erect a Perpendicular, as B E.



Open your Compasses to any convenient Distance, as B C, and draw the Arch C D; lay a Ruler to C and D, and draw the dotted Line C D E, as long as you please; take the Distance C D in your Compasses, and set from D to E, where you may, if you please, strike an Arch, and where it cuts the Line C E, which is in E, there lay a Ruler to B, and draw B E, which shall be perpendicular to A B, as was required.

PROB. V. To draw Lines parallel to each other.

Parallel Lines are those that being continued ever so far will never meet.

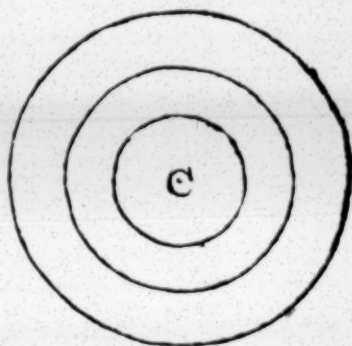
Let the Line given be A B, unto which I would draw a parallel Line. Open your Compasses to any convenient Distance, and set one Foot in A, draw an Arch at C, and carry this Extent to B, then draw the Arch at D, lay a Ruler to touch the Arches C and D, and draw the right Line C D, which is parallel to A B, as was required.

N. B. There is a Ruler sold at the Mathematical Instrument-Makers, which greatly supplies the Use of this Problem, known by the Name of the *Parallel Ruler*, which I recommend to all my Readers as very useful.

PROB.

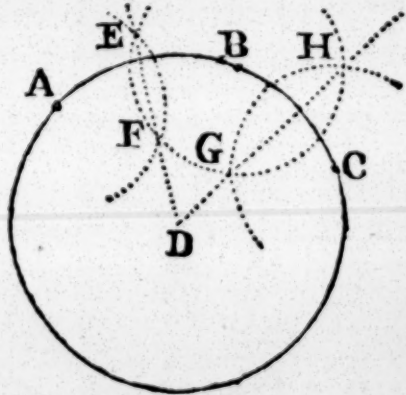
PROB. VI. *To draw parallel or concentric Circles.*

The Word *concentric* signifies having *the same* Center, and several Circles drawn from the same Center are said to be *concentric*: therefore set one Foot of your Compasses in C the *Center*, and open the other Foot to the Distance of your Circle intended, and draw a Circle; keep the Foot of your Compasses in the same Center, and open the other to the Distance of *another* Circle, which draw, and do so by as many as you intend, as is more clear by the Figure.



PROB. VII. *To find a lost Center, which is the same as to find a Center that will pass through any three Points not in a right Line.*

Let the *three* Points given be A B and C, through which I would draw a Circle. Set one Foot of the Compasses at A, and open them to any Extent *more than half* the Distance A B, and draw the Arch EF; carry the *same Extent* of the Compasses, and set one Foot in B; draw the Arch EGH, with the *same Extent*; set one Foot in C, and draw the Arch HG; lay a Ruler to EF, and draw the Line ED continued at Pleasure; lay a Ruler to HG, and draw the Line HD, and it will meet with ED, in D the *Center* of the Circle, from

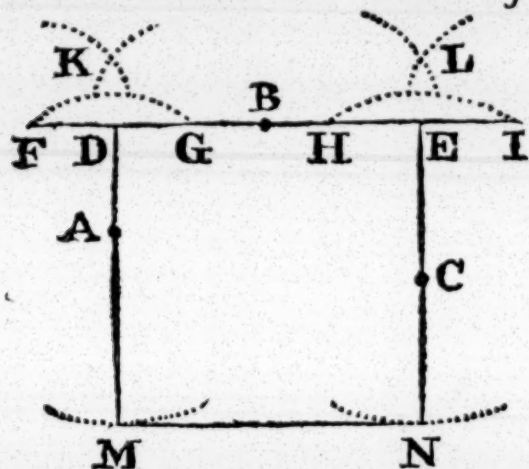




which Center draw a Circle with the Distance DA, and it will pass through the three given Points ABC, as was required.

PROB. VIII. Three Points, *not in a right Line*, given to make a geometric Square.

Let the *three Points* given be ABC; thro' the Point B draw the Line FI, set one Foot of the Compasses in the Point A, and draw the Arch FG; set one Foot of the Compasses in the Point C, and draw the Arch HI; set one Foot of the Compasses in H and I *severally*, and draw the two Arches at L; set one Foot in F and G *severally*, and draw the two Arches at K; lay a Ruler to L and C, and draw a Line with the Point of your Compasses; lay a



Ruler to K and A, and draw another Line with the Point of your Compasses; then take DF in your Compasses, and set one Foot thereof in D and E *severally*, and draw the Arches at M and N, and where those Arches

cut that Line drawn with the Point of your Compasses, that determinates the Length of the Lines DM, and EN, which draw with Ink, and it is done.

PROB. IX. To make a Line of Chords to any assigned Radius or Length.

Plate 2. Fig. 1.

RADIUS, in Geometry, signifies *half* the Diameter of any Circle equal to CB; and the Chord of an Arch is like the String of a Bow,

z. c.

## Chap. I. *Mechanick Dialling.*

7

*i. e.* it is a Line drawn from *any Point* in the Circumference of a Circle, to *any other Point* in the same Circle, as the Lines B 10, B 20, B 30, B 40, B 50, B 60, B 70, B 80, B 90, are the Chords of their respective Arches.

*First*, draw the *Quadrant* BC 90, and divide the Arch into 90 *equal* Parts, which number with 10, 20, 30, &c. to 90 *Deg.* set one Foot of your Compasses in B, and draw the Arch 90 A 90, so shall the Line AB be the *Chord* of 90, to the *Radius* CB; because all the *Chords* in the Arch B, 10, 20 and 90, are carried into the straight Line AB; set one Foot of the Compasses again in B, and carry the *Degrees* in the Arch into the Line AB, and number them with 10, 20, 30, &c. from B to 90 at A, so shall you have a *Line of Chords*, and thus may you make one of what Length you please.

**PROB. X.** *To draw a Line, or Scale, of six Hours.*

Plate 2. Fig. 2.

With any *convenient* Opening of the Compasses, draw the *Quadrant* ABC, divide the Arch into *six* equal Parts, and draw the *Chord* AC; lay a Ruler to the *Center* B, and to *every* Division in the Arch, and it will divide the *Chord* AC into a Scale of six Hours. See the Figure.

**PROB. XI.** *To make a Scale of Inclination of Meridians.*

Plate 2. Fig. 3.

With the same *Radius*, or Opening of the Compasses, that you drew the *Quadrant* of the Scale of the six Hours, draw the *Quadrant* ABC; divide the Arch into *nine* equal Parts, and every one of them into *ten*, so will the *Quadrant* be divided into 90 equal Parts, or *Degrees*; then draw the *Chord*  
B 4
AC;

AC; lay a Ruler to the Center B, and to every Division in the Arch, and it will divide the Chord AC into a Scale of Inclination of Meridians, equal to that of the Scale of six Hours.

PROB. XII. To make a Line or Scale of Latitudes.

Plate 2. Fig. 4.

To proportion this Scale to the other two last mentioned, the Scale of Latitudes must be the Chord of 60 Deg. to the same Circle, in which the Scale of six Hours is the Chord of 90 Deg.

In either of the Problems X or XI, set one Foot of the Compasses in B, and take the nearest Distance to the Chord AC, with that Extent draw the Semi-circle DIF, and divide the Quadrant DI into 90 equal Parts or Degrees, and number them with 10, 20, 30, &c. to 90; then, by Prob. V. or rather with your Parallel Ruler, draw the Lines 10a, 20c, 30e, &c. parallel to DE; lay a Ruler to D, and to a, c, e, g, i, l, p, and I severally, and draw Dab, Dcd, Def, Dgb, Dik, Dlm, Dno, Dpq, and DI, and setting one Foot of the Compasses in F, carry the Points b, d, f, h, k, m, o, q, and I, into the Line FG, and number it with 10, 20, 30, 40, 50, 60, 70, 80, 90, which shall be a Line of Latitudes to the given Radius. Lastly, carry the Points 10, 20, 30, 40, 50, 60, 70, 80, 90, in the Arch DI, into the Line DH, and that shall be a Line of Chords, answering the Line of Latitudes, Inclination of Meridian and Hours.

PROB. XIII. To make a Quadrant.

A QUADRANT is a very useful Instrument in Dialling, and is the fourth Part of a Circle, of any Opening of your Compasses, whatever you please:  
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# The Seven liberall Sciences

Grammar teacheth y<sup>e</sup> art of writing  
& Speaking Languages

Rhetorick y<sup>e</sup> art of Speaking & Disputing  
on any topick whatsoever

Logick y<sup>e</sup> art of Reasoning well whereby  
you may find out truth by fallshood

Arithmetick teacheth y<sup>e</sup> Vertue of  
Numbers

Geometry teacheth y<sup>e</sup> art of Measuring

Musick y<sup>e</sup> Vertue of Sounds

Astronomy y<sup>e</sup> knowledge of y<sup>e</sup> heavenly  
Bodys

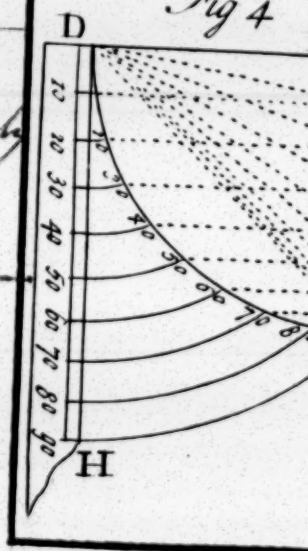
Fig I



Pl

The Differa  
used in Dia

Fig 4



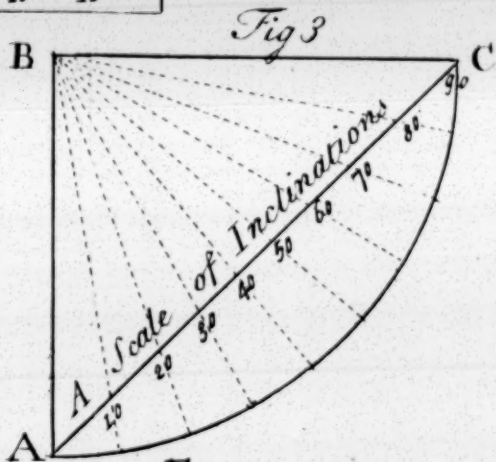
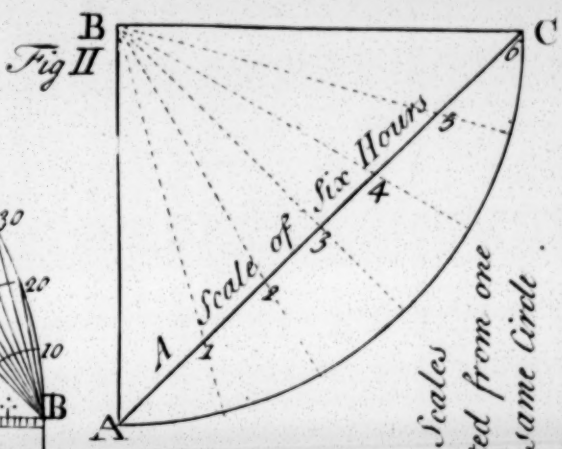
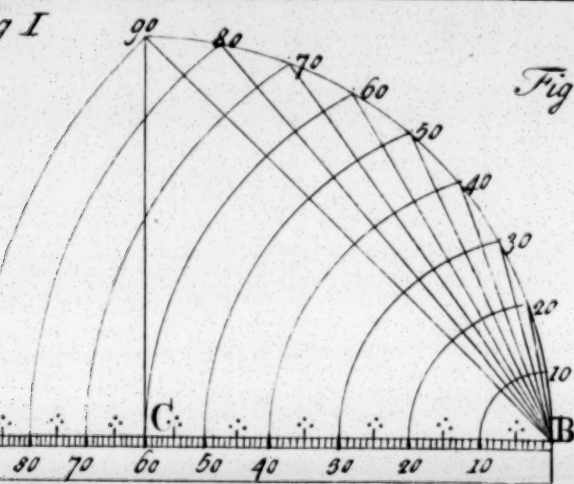
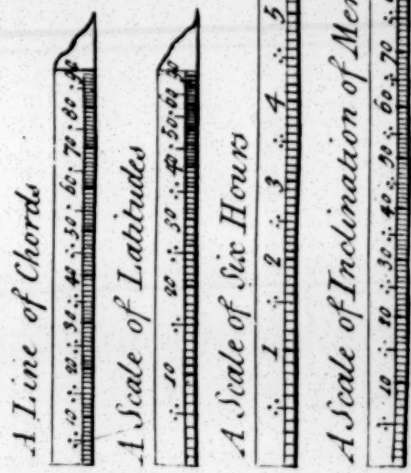
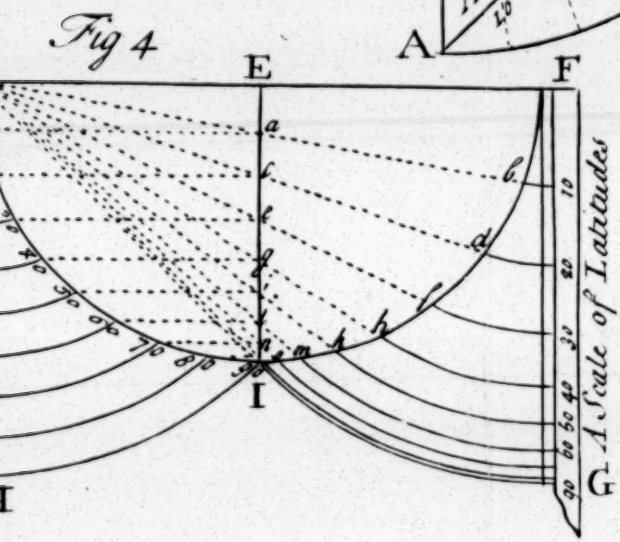


Plate 2

The Differant Scales  
used in Dialling.

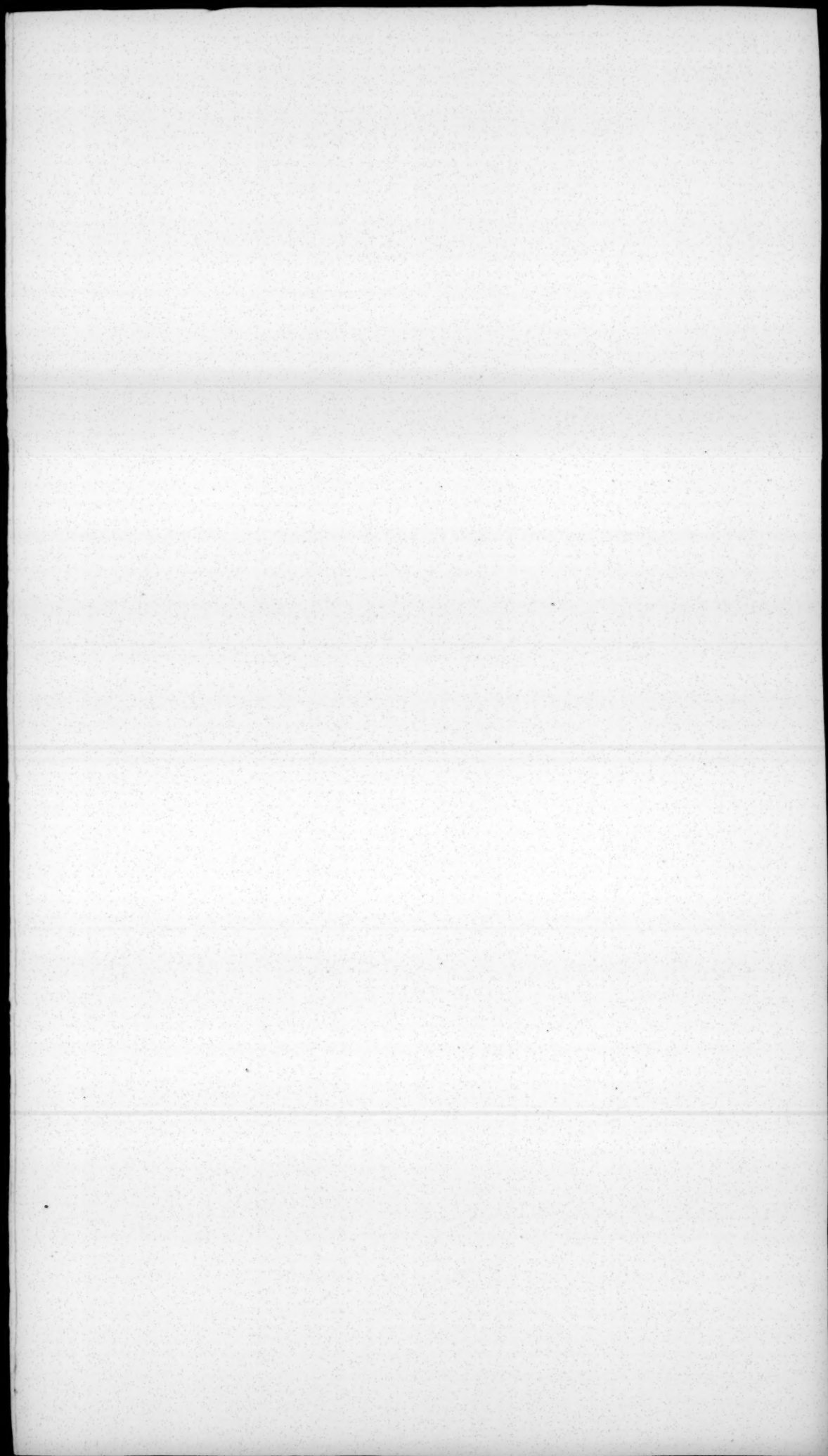
NB These four Scales  
are all Projected from one  
Radius of the same Circle





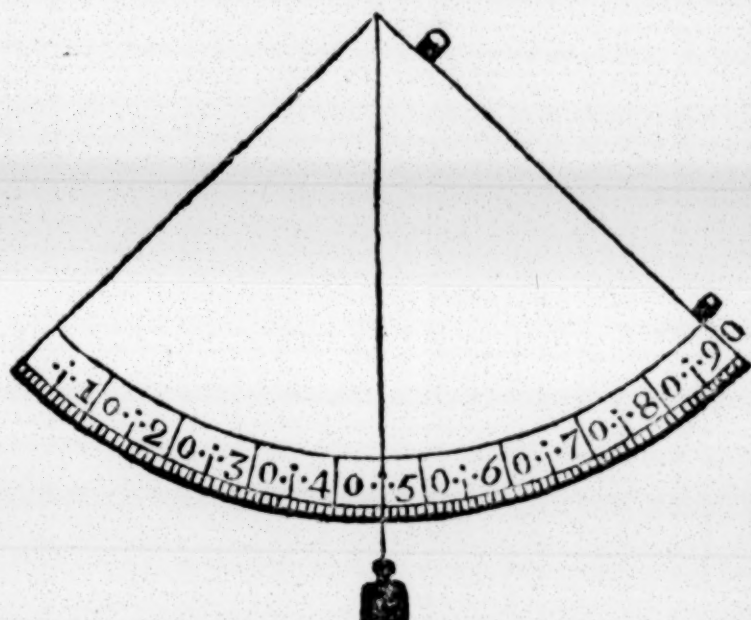








The *Limb* or *Arch* thereof is divided into 90 *equal Parts*, called *Degrees*, and numbered with 10, 20, 30, &c. to 90. It has on one *Edge* two *Sights*, as



the annexed Figure. There are two Sorts commonly sold in *London*, known by the Name of *Gunter's* and *Collins's* Quadrants, which have *Lines of Hours* and *Azimuth* drawn on the *Face*, to shew the *Hour* of the Day or Night, and the *Azimuth* of the Sun, at any Time, for the Latitude of *London* only.

N. B. If you buy either of these Quadrants, and take them far *North* or *South* from *London*, they will *there* be of no Service to you in finding the *Hour* and *Azimuth*, || but only in taking an *Altitude*, and other Purposes in Dialling, as will be shewn in its proper Place.

If you procure a good seasoned Board that will not

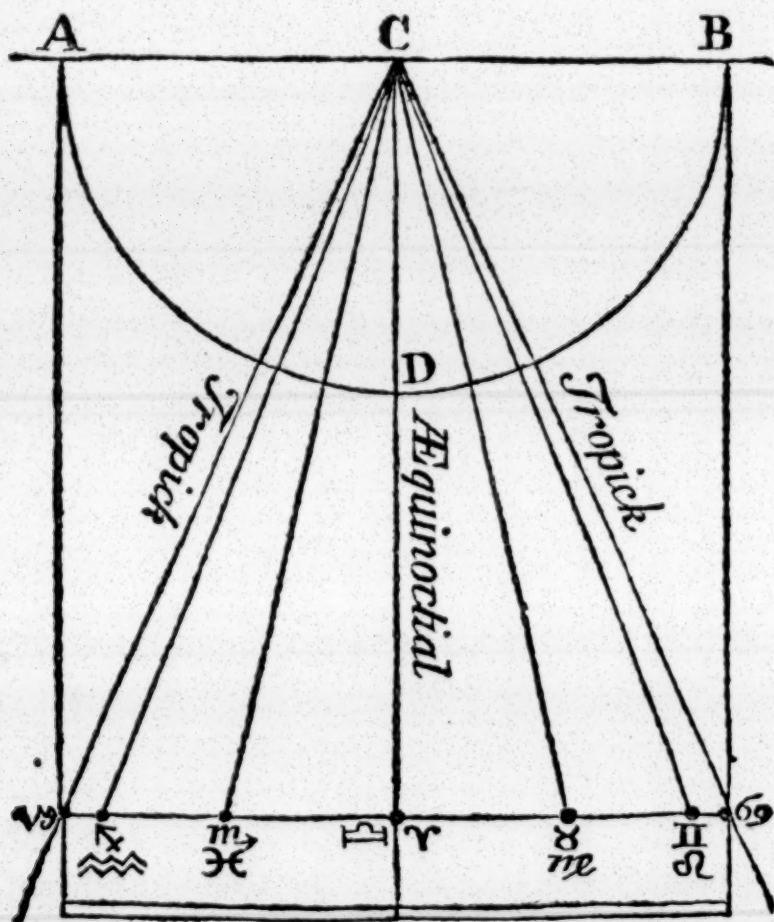
|| Those that would draw the *Hours* and *Azimuths* on a Quadrant, to any particular Latitude, may have Recourse to my *System of Astronomy*, Vol. I. where they will find full Directions for those Purposes.

warp,

warp, and thereon paste a Sheet of good Paper, and draw such a *Quadrant* as above represented, and fix thereto a *Thread* and *Plummet*, it will serve your Purpose well enough.

PROB. XIV. *To make a Trigon.*

The TRIGON is likewise a very useful Instrument in Dialling, and may be made upon a thin Board, or Sheet of good Paste-board, as is the Figure A B vs,



of any convenient Size you please. At right Angles to A B, draw C D r, which shall represent the *Equinoctial*; with the *Chord* of 60 Degrees, draw the *Semicircle* A D B; take in your Compasses from the *Line of Chords* (Plate 2. Fig, 1.) 11 Deg. 30 Min. (for

(for such is the Sun's Declination when he enters  $\varnothing$   $\pi$  North, and  $\text{m} \times$  South) and set one Foot in the Point D, that is, where the *Equinoctial* CD  $\gamma$  cuts the *Semicircle*, and turn the other Point *each Way* upon the Arch, there make Marks, and draw C  $\varnothing$   $\pi$ , and C  $\text{m} \times$ : These two Lines shall represent the *Sun's Declination* in the *Trigon*, when he enters *those Signs*. Take 20 Deg. 11 Min. from your *Line of Chords*, (Plate 2. Fig. 1.) and set it from D, *each Way* upon the Arch, and thro' *those* Points draw C  $\pi$   $\delta$ , and C  $\gamma$   $\approx$ , these *two* Lines in the *Trigon* shall represent the Sun's Declination *North* and *South*, when he enters *those Signs* \*

Lastly, take 23 Deg. 29 Min. from your *Chords*, and set it from D *each Way* upon the Arch, and draw the *two* Tropicks of *Cancer* and *Capricorn*. At the *End* of *those* Lines, *close by* the Signs (where you see the Dots) you must make small Holes, through which to put a Thread; and thus is your *Trigon* finished, and fitted for the inserting of the *Parallels* of the *twelve Signs* into all Sorts of Sun-Dials, either *direct* or *reclining*.† But if you would put in *other* *Parallels* of Declination, such as when the Days are just 8, 9, 10, 11, 12, 13, 14, 15, or 16 Hours long, then you must insert into your *Trigon* such Degrees of Declination as the Sun hath, when the Days are so many Hours long, as you would describe upon your Dial; and so in the Latitude of *London*,

\* The Sun's Declination is his Distance either *North* or *South* from the *Equinoctial*. N. B. It is *North* from the 21<sup>st</sup> of *March* to the 22<sup>d</sup> of *September*, and the rest of the Year it is *South*. See Table I.

† The *Parallels* of the 12 *Signs* are the Sun's Declination that Day that he enters any *Sign*; as for Example, *Taurus* 11 Deg. 30 Min. as you find it in Table I.

When



|                                 |   |                    |   |    |   |                      |   |                                   |   |                     |   |                                   |   |                 |
|---------------------------------|---|--------------------|---|----|---|----------------------|---|-----------------------------------|---|---------------------|---|-----------------------------------|---|-----------------|
| When<br>the<br>Day is<br>either | { | 8<br>9<br>10<br>11 | } | or | { | 16<br>15<br>14<br>13 | } | Hours<br>long,<br>the sun<br>hath | { | 21<br>16<br>11<br>5 | } | Deg. Min.<br>40<br>55<br>37<br>55 | } | Of Declination. |
|                                 |   |                    |   |    |   |                      |   |                                   |   |                     |   |                                   |   |                 |
|                                 |   |                    |   |    |   |                      |   |                                   |   |                     |   |                                   |   |                 |
|                                 |   |                    |   |    |   |                      |   |                                   |   |                     |   |                                   |   |                 |

N. B. By the 25th Prob. of my *System of Astronomy*, Page 146, you may find the Declinations for any other Latitude.

## CHAP. II. Of DIALLING in General.

**D**IALLING is a very *curious* and *useful* Art, and teacheth us how to draw *Hour-Lines* upon all Sorts of *Surfaces*, or *Planes*, for any Place in the World, and thereby to know the apparent Hour of the Day, by the Shadow of a *Stile*\* fixed on the Plane *parallel to the Earth's Axis*, which *Stile* can have no more than *three* Positions, *viz.* *Perpendicular*, *Oblique*, or *Parallel*, which shall be shewn in their proper Places.†

A *Dial-Plane* is that Flat on which a Dial is intended to be projected.

The *Dial-Planes*, on which Hour-Lines are drawn, are these following:

\* The *Stile* in Dialling signifies the Pin or Cock of a Dial, the Shadow of which points out the Hour.

† The whole Business of Dialling may be reduced to *three* general Heads; the *first* consists in finding the Place of the *Substile*, or where the *Stile* is to be placed; the *second* in drawing the *Hour-Lines*; and the *third*, and last, if the Dial-Plane be *moveable*, in duly placing and fixing the same, after the Dial is drawn thereon; or else, if the Plane, whereon the Dial is to be drawn, be *unmoveable*, and already fixed, in finding the *Position* or Situation of the said Plane, *viz.* whether it be a *direct* or *declining* Plane, and if the latter, how far it declines.

The

The Horizontal  
 The North and South erect direct  
 The erect Decliner  
 The Reclining Inclining  
 The Reclining Declining  
 The Convex  
 The Concave

} Dial-Plane.

The *Equinoctial* Dial-Plane is that which is *parallel* to the Plane of the *Earth's Equator*, and is *universal*; for Hour Lines drawn thereon, will shew the apparent Time of the Day in any Place of the World; and because this is the *Ground* and *Foundation* of all other Dials, therefore I shall begin *first* with it, and, in the Course of this Work, shall shew how naturally the *Hour-Lines*, upon all Sorts of Dial-Planes, are deduced from the *Equinoctial* Dial; but shall *first* furnish you with the following Table.

---

*A new correct alphabetical Table of the principal CITIES and TOWNS in England, Scotland, Ireland, and Wales, \* shewing at each Place the Elevation of the Pole, and Difference of their Meridians from London.*

☞ The *Elevation of the Pole* signifies the same as the *Latitude of the Place*; and the *Difference of Meridians*, the same as the *Longitude of the Place*.

NOTE,

|                   |             |                             |  |                          |             |                                |                             |
|-------------------|-------------|-----------------------------|--|--------------------------|-------------|--------------------------------|-----------------------------|
| D }<br>H }<br>M } | signifies { | Degrees<br>Hours<br>Minutes |  | E }<br>W }<br>N }<br>S } | signifies { | East<br>West<br>North<br>South | { Longitude.<br>{ Latitude. |
|-------------------|-------------|-----------------------------|--|--------------------------|-------------|--------------------------------|-----------------------------|

\* N. B. There is a Table of the most eminent *Cities and Towns* in the *World*, in *Chapter XXIV*, near the latter End of this Work.

*England.*

14 *A new Table of the Elevat. of the Pole, &c*

|                |       |       |   | Latit. Diff. Merid |                  |       |      |   | Latit. Diff. Merid |
|----------------|-------|-------|---|--------------------|------------------|-------|------|---|--------------------|
| England.       | D. M. | H. M. |   |                    | D. M.            | H. M. |      |   |                    |
| <b>B</b> ATH   | 51    | 25 N  | 0 | 8 W                | Nottingham       | 52    | 17 N | 0 | 4 W                |
| Bedford        | 52    | 6 N   | 0 | 2 W                | Ormkirk          | 53    | 30 N | 0 | 12 W               |
| Berwick        | 55    | 45 N  | 0 | 7 W                | Orfordness       | 52    | 14 N | 0 | 6 E                |
| Bristol        | 51    | 26 N  | 0 | 11 W               | Oxford           | 51    | 45 N | 0 | 5 W                |
| Buckingham     | 51    | 57 N  | 0 | 4 W                | Penzance, Corn-  |       |      |   |                    |
| Cambridge      | 52    | 12 N  | 0 | 0 W                | wall             | 50    | 8 N  | 0 | 24 W               |
| Canterbury     | 51    | 16 N  | 0 | 5 E                | Peterborough     | 52    | 33 N | 0 | 1 W                |
| Carlisle       | 54    | 48 N  | 0 | 10 W               | Portsmouth       | 50    | 48 N | 0 | 5 W                |
| Chester        | 53    | 10 N  | 0 | 12 W               | Preston, Lanca-  |       |      |   |                    |
| Chichester     | 50    | 52 N  | 0 | 3 W                | shire            | 53    | 42 N | 0 | 11 W               |
| Colchester     | 51    | 57 N  | 0 | 4 E                | Richmond, in     |       |      |   |                    |
| Coventry       | 52    | 26 N  | 0 | 6 W                | Yorkshire        | 54    | 20 N | 0 | 6 W                |
| Cronton in     |       |       |   |                    | Rochester, Kent  | 51    | 23 N | 0 | 3 E                |
| Lancashire     | 53    | 22 N  | 0 | 12 W               | Salisbury        | 51    | 7 N  | 0 | 8 W                |
| Derby          | 52    | 58 N  | 0 | 6 W                | Shrewsbury       | 52    | 42 N | 0 | 11 W               |
| Dorchester     | 50    | 43 N  | 0 | 11 W               | Southampton      | 50    | 53 N | 0 | 6 W                |
| Dover          | 51    | 5 N   | 0 | 5 E                | Stafford         | 52    | 45 N | 0 | 9 W                |
| Durham         | 54    | 47 N  | 0 | 5 W                | Stamford, Lin    |       |      |   |                    |
| Exeter         | 50    | 49 N  | 0 | 14 W               | colnshire        | 52    | 37 N | 0 | 1 W                |
| Flamborough    | 54    | 9 N   | 0 | 1 E                | Truro            | 50    | 10 N | 0 | 22 W               |
| Falmouth in    |       |       |   |                    | Wigan            | 53    | 34 N | 0 | 11 W               |
| Cornwall       | 50    | 9 N   | 0 | 22 W               | Weymouth         | 50    | 37 N | 0 | 10 W               |
| Gloucester     | 51    | 51 N  | 0 | 9 W                | Warrington       | 53    | 24 N | 0 | 10 W               |
| Guilford       | 51    | 15 N  | 0 | 3 W                | Warwick          | 52    | 18 N | 0 | 6 W                |
| Harborough in  |       |       |   |                    | Wells, Somersfet | 51    | 15 N | 0 | 11 W               |
| Leicestershire | 52    | 27 N  | 0 | 5 W                | Winchelsea       | 50    | 57 N | 0 | 3 E                |
| Hereford       | 52    | 4 N   | 0 | 11 W               | Winchester,      |       |      |   |                    |
| Hertford       | 51    | 48 N  | 0 | 0 W                | Hants            | 51    | 7 N  | 0 | 5 W                |
| Hull           | 53    | 46 N  | 0 | 1 W                | Wolverhamp-      |       |      |   |                    |
| Huntingdon     | 52    | 18 N  | 0 | 1 W                | ton              | 52    | 38 N | 0 | 9 W                |
| Ipswich        | 52    | 8 N   | 0 | 5 E                | Woodstock        | 51    | 50 N | 0 | 6 W                |
| Kendal         | 54    | 13 N  | 0 | 11 W               | Worcester        | 52    | 13 N | 0 | 9 W                |
| Lancaster      | 54    | 0 N   | 0 | 11 W               | Yarmouth, Nor-   |       |      |   |                    |
| Leicester      | 52    | 37 N  | 0 | 5 W                | folk             | 52    | 44 N | 0 | 7 E                |
| Lincoln        | 53    | 13 N  | 0 | 2 W                | York             | 53    | 55 N | 0 | 4 W                |
| London*        | 51    | 32 N  | 0 | 0 W                |                  |       |      |   |                    |
| Liverpool      | 53    | 25 N  | 0 | 12 W               |                  |       |      |   |                    |
| Litchfield     | 52    | 42 N  | 0 | 7 W                |                  |       |      |   |                    |
| Manchester     | 53    | 28 N  | 0 | 9 W                |                  |       |      |   |                    |
| Newcastle upon |       |       |   |                    |                  |       |      |   |                    |
| Tyne           | 55    | 1 N   | 0 | 5 W                |                  |       |      |   |                    |
| Northampton    | 52    | 12 N  | 0 | 4 W                |                  |       |      |   |                    |
| Norwich        | 52    | 42 N  | 0 | 6 E                |                  |       |      |   |                    |

|                     |       |       |   | Latit. Diff. Merid |       |       |  |  | Latit. Diff. Merid |
|---------------------|-------|-------|---|--------------------|-------|-------|--|--|--------------------|
| Wales.              | D. M. | H. M. |   |                    | D. M. | H. M. |  |  |                    |
| <b>B</b> Angor, Bi- |       |       |   |                    |       |       |  |  |                    |
| shop's See          | 3     | 21 N  | 0 | 17 W               |       |       |  |  |                    |
| Beaumaris           | 53    | 18 N  | 0 | 17 W               |       |       |  |  |                    |
| Brecknock           | 51    | 54 N  | 0 | 14 W               |       |       |  |  |                    |
| Caermarthen         | 51    | 53 N  | 0 | 18 W               |       |       |  |  |                    |
| Caernarvan          | 53    | 10 N  | 0 | 18 W               |       |       |  |  |                    |

\* Mr. Norwood, in his *Seaman's Practice*, Page 20, makes the Latitude of London 51 D. 30 M. and of York 53 D. 38 M. consequently the Difference of Latitude between them is 2 D. 8 M.

## Cardiff



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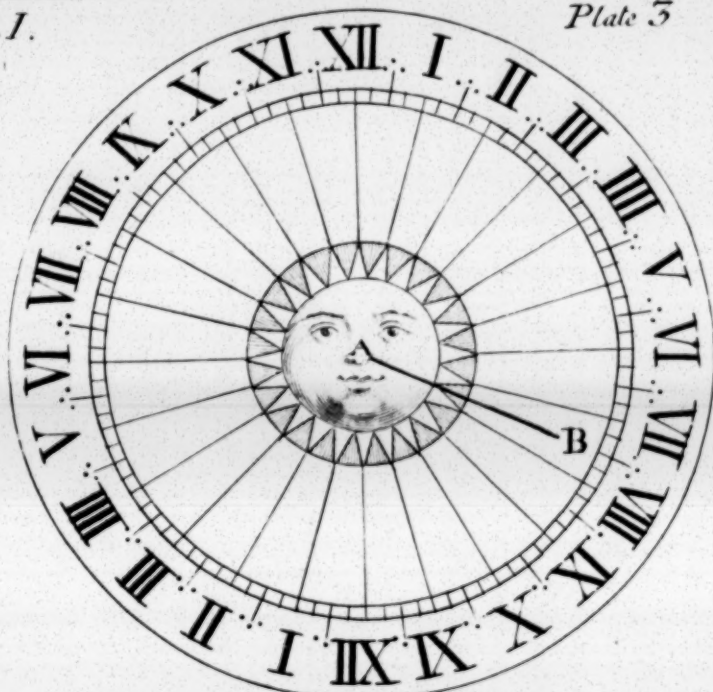
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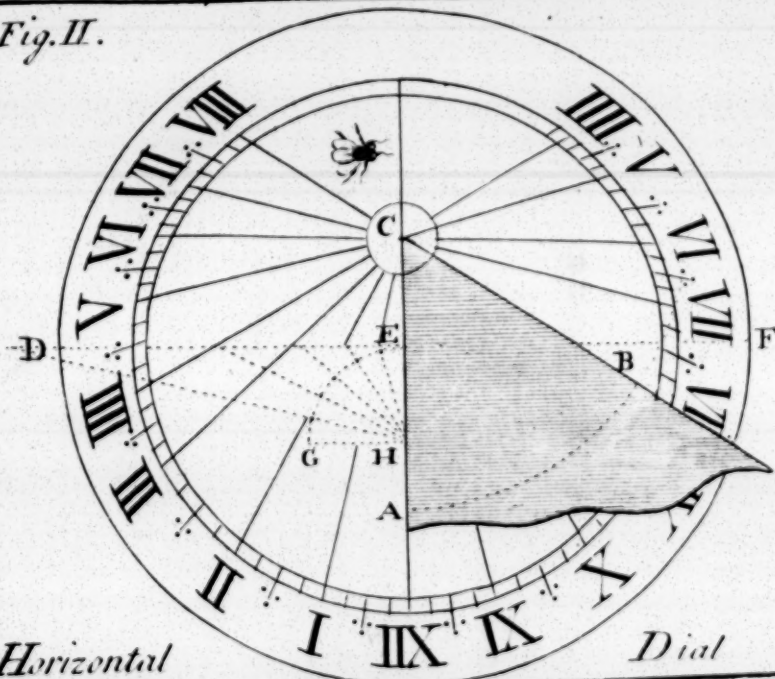
Fig. I.

Plate 5



An Equinoctial Universal Dial

Fig. II.



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# Diff. of Merid. for G. Britain, Ireland, &c. 15

|                            |        | Latit. Diff. Merid. |       |                 |        | Latit. Diff. Merid. |       |
|----------------------------|--------|---------------------|-------|-----------------|--------|---------------------|-------|
|                            |        | D. M.               | H. M. |                 |        | D. M.               | H. M. |
| Cardiff                    | 51 42N | 0                   | 13 W  | Dumblain        | 56 14N | 0                   | 16 W  |
| Cardigan                   | 52 8N  | 0                   | 19 W  | Dunkeld         | 56 37N | 0                   | 13 W  |
| Denbigh                    | 53 10N | 0                   | 14 W  | Edinburgh       | 55 57N | 0                   | 12 W  |
| Flint                      | 53 12N | 0                   | 13 W  | Glasgow         | 56 20N | 0                   | 17 W  |
| Harlech, in Merionethshire | 52 53N | 0                   | 17 W  | Leith           | 54 58N | 0                   | 12 W  |
| Landaff                    | 51 43N | 0                   | 13 W  | Orkney          | 60 6N  | 0                   | 14 W  |
| Milford                    | 51 43N | 0                   | 20 W  | St. Andrews     | 56 19N | 0                   | 10 W  |
| Monmouth                   | 51 50N | 0                   | 11 W  | Stirling        | 56 10N | 0                   | 15 W  |
| Montgomery                 | 52 34N | 0                   | 13 W  | <i>Ireland.</i> |        |                     |       |
| Pembroke                   | 51 42N | 0                   | 20 W  | <b>A</b> Ntrim  | 54 47N | 0                   | 26 W  |
| Radnor                     | 52 21N | 0                   | 12 W  | Ardglas         | 54 19N | 0                   | 24 W  |
| St. Asaph                  | 53 15N | 0                   | 13 W  | Armagh          | 54 22N | 0                   | 28 W  |
| St. Davids                 | 55 1N  | 0                   | 21 W  | Belfast         | 54 36N | 0                   | 27 W  |
| Welshpool                  | 52 40N | 0                   | 13 W  | Caterlagh       | 52 48N | 0                   | 29 W  |
| Wrexham                    | 53 2N  | 0                   | 13 W  | Clare           | 52 41N | 0                   | 37 W  |
| <i>British Islands.</i>    |        |                     |       | Cork            | 51 45N | 0                   | 36 W  |
| <b>A</b> nglesey           |        |                     |       | Colerain        | 55 8N  | 0                   | 28 W  |
| Middle                     | 53 20N | 0                   | 18 W  | Drogheda        | 53 43N | 0                   | 26 W  |
| Guernsey                   | 49 36N | 0                   | 11 W  | Dublin          | 53 16N | 0                   | 26 W  |
| Jersey                     | 49 28N | 0                   | 14 W  | Dundalk         | 54 3N  | 0                   | 27 W  |
| Lundy                      | 51 20N | 0                   | 15 W  | Galloway        | 53 12N | 0                   | 32 W  |
| Man                        | 54 25N | 0                   | 18 W  | Kenny           | 52 39N | 0                   | 30 W  |
| Portland                   | 50 30N | 0                   | 11 W  | Kildare         | 53 8N  | 0                   | 29 W  |
| Wight                      | 50 37N | 0                   | 6 W   | Kinsale         | 51 31N | 0                   | 38 W  |
| Yarmouth in ditto          | 50 44N | 0                   | 7 W   | Londonderry     | 54 55N | 0                   | 32 W  |
| <i>Scotland.</i>           |        |                     |       | Limerick        | 52 36N | 0                   | 31 W  |
| <b>A</b> berdeen           | 57 6N  | 0                   | 7 W   | Maryborough     | 53 0N  | 0                   | 31 W  |
| Dunbar                     | 55 57N | 0                   | 9 W   | Philipstown     | 53 15N | 0                   | 31 W  |
| Dundee                     | 56 30N | 0                   | 13 W  | Tuam            | 53 26N | 0                   | 37 W  |
|                            |        |                     |       | Waterford       | 52 13N | 0                   | 29 W  |
|                            |        |                     |       | Wexford *       | 52 19N | 0                   | 27 W  |
|                            |        |                     |       | Youghall        | 51 51N | 0                   | 33 W  |

## CHAP. III. To make an Equinoctial \* Dial.

Plate 3. Fig. 1.

**T**HIS Dial, of all others, is the most simple and easy to be drawn, and is thus made:

\* *Equinoctial Dials* are those whose *Plane or Face* lieth *parallel* to the Equinoctial.

Take

## 16 *Of the Equinoctial Dial.* Chap. III.

Take a *flat* Plate of Brass, about a Foot square; or if you cannot easily procure Brass, get a Piece of good dried Oak, well planed on both Sides.

### *For the Hour-Lines.*

Draw with your Compasses *three* † *concentric Circles* thereon, to contain the Figures, which divide into 24 *equal Parts*; then lay a Ruler to the *Center*, and draw Lines to those *equal Divisions* in the *Circle*, and they shall be the true *Hour Lines* sought.

### *For the Stile.*

Erect in the *Center* of the Plate a Pin or Wire *perpendicular* to the Plane, as AB, and that shall be the *Stile* truly fitted to the Dial.

You must observe, that 15 *Deg.* || in the *Equinoctial* is *one Hour in Time*, as you may see more at large by Table III, and therefore, if you take 15 *Deg.* from your *Line of Chords*, and set it off from the 12 *a-clock Line each Way*, that will give you the Hours of 11 and 1, and 30 *Deg.* will give you the Hours of 10 and 2, &c. and thus the whole *equinoctial Circle* will be divided into 24 *equal Parts* or *Hours*, as above.

But because this Dial, when thus drawn on *one* Surface or *Side* of the Plane, will serve only for one Half of the Year, *viz.* while the Sun is on *one Side* of the *Equinoctial*, to wit, from the 22d of *March* to the 21st of *September*; and therefore to make it

† See Problem VI. Page 5.

|| Throughout this Book you will find continual Mention made of *Degrees* and *Minutes*, therefore you are to remember, that a *Degree* is the 360th Part of any Circle; each of which *Degrees* is supposed to be divided into 60 *Minutes*; so that 45 *Minutes* is *three Quarters* of a *Degree*, 30 *Minutes* *Half* a *Degree*, and 15 *Minutes* a *Quarter* of a *Degree*, &c. See Table III.

### Chap. III. Of the Equinoctial Dial.

17

serve for the *whole Year*, it must be *doubly* drawn, *i.e.* on the *lower*, as well as on the *upper Side* or Surface of the Plane, and then the Wire, which serves for the *Stile*, must go through the *Center*, and must extend itself 6 or 8 Inches more or less *beyond* the Surface of the Plane, and stand at *right Angles* therewith; and *then is that Dial finished*. How naturally the *Hour Lines* of all Dials are drawn from the *Equinoctial Dial* is shewn in Chapter XXI.

*To set this Dial truly.*

You must raise the Wire, which represents the *Stile*, to the *Latitude* of your Place, by applying that Edge of your *Quadrant*, in which the Sights are fixed, to the *Stile*, and when the *Thread* cuts the *Limb* in the *Degrees* of the *Latitude* of your Place, then doth the *Stile* point to the *Poles of the World*, and the Dial itself *lieth parallel* to the *Equinoctial Circle* in the Heavens. But still here wants a *true 12 a-clock Hour Line*, which must be found as I shall shew in the next Chapter, and then placing the Dial, so that at *12 a-clock* the *Shadow* of the *Stile* may fall in the *12 a-clock Hour Line*, that you find by the Directions following: and thus will your Dial be *truly placed*, which you may fasten by fixing two Pieces of Iron at each End of your *12 a-clock Hour Line* upon your *Dial Post*, and in those put the *Stile* of the Dial to the *Height*, which was found before by the Help of your *Quadrant*.

C

CHAP.



## CHAP. IV. To make an Horizontal \* Dial.

Plate 3. Fig. 2.

THIS is the most *useful* Dial of all others, because the Sun stayeth upon it from his *Rising* to his *Setting*, in all Places of the World, whereſoever you be.

It matters not what Form the Plane, on which you would draw an *Horizontal Dial*, is, whether it be *round*, *square*, or *triangular*, but they are generally drawn round, as on Plate 3. Fig. 2. in which, when you have drawn *three concentric Circles*, as a Margin to contain the Figures, draw the Line CA, which ſhall repreſent the 12 *a-clock Line*, and alſo the *ſubſtilar Line*, in which make choice of a Point, as at C, a little above the *Center* (for by that Means you will enlarge the *Distances* of the *Hour Lines*) and through it draw the Line VI. C. VI. for the 6 *a-clock Hour Line*. In the *ſubſtilar Line*,† as at E, make choice of *another Point*, and through that, at *right Angles* to the 12 *a-clock Line*, draw the Line DEF; having proceeded thus far, let it be required to make an *Horizontal Dial* to the Latitude of *Durham*, which is 54 Deg. 47 Min. *North*; open your *Compaſſes* to the *Chord* of 60 Deg. ſet one Foot in C, draw the Arch AB, and take the *Chord* of 54 Deg. 47 Min. and ſet it from A to B, and draw the Line CB for the *Stile*, ſo is ACB the

\* *Horizontal Dials* are thoſe whoſe *Plane* or *Face* lies parallel to the *Horizon* of the Place.

† The *ſubſtilar Line* in *Dialling* is that Line drawn upon the *Plane* or *Face* of the Dial, over which the *Stile* ſtands perpendicular, or at *right Angles*. Note, This is not the 12 *a-clock Line* in all Dials, tho' it is in the *Horizontal* and *South*, and *North Erect Direct* Dials.

true Form and Shape of your *Dial Cock* or *Stile*; set one Foot of your Compasses in F, that is, where the Line DEF cuts the 12 *a-clock Line*, and take the nearest Distance to the Line CB, or *Stile's Height*, turn *that* Point of your Compasses about, and make another Mark in the 12 *a-clock Line* at H; this Point H represents the *Center* of the Equinoctial. On H, as a *Center*, draw the *Quadrant* GE, and divide it into *six equal Parts*; lay a Ruler to H, and to those *equal Parts* in the Arch *severally*, and where the Ruler cuts the Line DEF, the Points are through which the *Hour Lines* must pass; then lay a Ruler to the *Center* at C, and to those Marks in the Line DEF, and draw the *Hour Lines*; set off the *same* Distances in the Line DEF, from E towards B, and draw the *Morning Hours*; those *before six* in the Morning, and *after six* at Night, are drawn by continuing the *same Hour Line beyond the Center C*.

*How to set it truly.*

The Dial being thus finished, the next Thing is *to set it truly*; for if it be ever so truly made, and not well set, it will go wrong: therefore you must first see that your Post, on which the Dial is to stand, be truly level every Way, which you may try by your *Quadrant*, on which draw a *Circle* as large as the Top of the Post will bear; in the *Center* thereof place a Pin *exactly upright*; in the *Forenoon*, when the Sun shineth, let the *End of the Shadow* of the Pin touch the *Circle*, where *make a Mark*; let Things stand thus till *Afternoon* the same Day, and then observe where the *Top* of the Shadow of the Pin toucheth the same Circle; there again *make a second Mark*; then divide the Distance of these

20 *Of the erect direct South Dial.* Chap.V.

*two* Marks into *two equal Parts*, and from *that* through the *Center* draw a *Line*, which shall be the *12 a-clock Hour Line*, and set the *12 a-clock Line* of your *Dial* upon this *12 a-clock Line on the Post*; so shall your *Dial* be truly placed, which may be fastened at your own Discretion.

*Note*, Instead of the *Quadrant G E*, you may draw a *Semicircle* on the *Center H*, and divide it into *12 equal Parts*, and so *Lines* drawn from the *Center* at *H* will give the *Points* in the *Line D E F*, as before. Or, if you apply the *Center* of the *Equinoctial Dial* to the *Center* at *H*, the *Hour Lines* on the *Equinoctial Dial* will cut the *Line D E F* in the *Points* where the *Hour Lines* on the *Horizontal Dial* must pass.

*N. B.* For drawing the *Half Hours* and *Quarters*, upon all Sorts of *Dials*, you are to observe, that as you divided the *Circle*, which represented the *Equinoctial* (into *24 equal Parts*) for the *Hours*, so you are to divide each of those *Parts* into *4 equal Parts* more, and those will be the *Quarters*.

*N. B.* That in placing of *Dials*, when made, excepting the *Equinoctial* and *Horizontal Dial*, you have no Occasion to regard the *Place* where they are to be fixed, for the *Hour Lines* being drawn according to the *Declination* or *Reclination* of the *Place*, it gives you the *true Situation* of the *Dial* itself.

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CHAP. V. *To make an erect \* direct South Dial.*

Plate 4. Fig. 2.

THIS *Dial Plane* is no more than an *upright* Wall, which *exactly* faces the true *South Point*.  
As

\* 1. Those *Planes* are said to be *erect* or *upright*, which stand *perpendicular* to the *Horizon* of the *Place*; and such are the *Walls* of *Churches*, *Houses*, or the like, against which, for the most Part, *Dials* are placed.  
2. Of



## Chap.V. Of the erect direct South Dial. 21

As the *Elevation of the Pole* above the *Horizontal Plane* was equal to the *Latitude of the Place*: so in this it is the *Complement of the Latitude* of the Place, or what it wants to make it up 90 Degrees.

The Sun never stays 12 Hours upon this Plane, but when in the *Equinoctial*; because the Plane it self lieth in the *prime Vertical*, or *East and West Azimuth*; for, from *March 20*, to *September 23*, he doth not come due East till after 6 in the *Morning*, and is due West before 6 at Night: so that when in the *Tropic of Cancer*, he is due East at 7 H. 20 M. 4 S. S. and due West at 4 H. 39 M. 12 S. consequently his Stay then upon the Plane is only 9 H. 18 M. 24 S. See my *Astronomy*, P. 104.

### For the Hour-Lines.

When you have made choice of your Plane, draw the *Horizontal Line* VI, VI, for the *East and West Line*, or *Hour Line of Six*; from A let fall the *Perpendicular* AF, for the 12 a-clock *Hour Line*; then with your *Compasses* take 60 Deg. from the *Line of Chords*, and draw the *Arch* BC VI; take the *Complement of the Latitude* of your Place, which, in this Example, I'll suppose to be *Chester*, whose *Latitude*, as you find it in the Table, is 53 Deg. 10 Min. North, and set 36 Deg. 50 Min. its *Complement*, or what it wants to make it up 90 Degrees from B to C; draw AC for the *Height of the Stile*.

2. Of these erect or upright Planes there are two Sorts, viz. Direct and Declining. 3. Those erect or upright Planes are said to be direct, which directly face the East, West, North, or South Points of the Horizon, and these are called erect direct Planes. 4. Those erect or upright Planes are said to decline, which do not directly face the East, West, North or South Points, but look upon some other Points situate betwixt them, viz. South East, North-West, North-East, &c. and these Planes are called upright or erect, declining Planes. How the Declination is to be found, is taught in Chap. X.

## 22 *Of the erect direct South Dial.* Chap.V.

Make choice of any Point, at Pleasure, in the 12 a-clock Line, as I; through I, at *right Angles* to the 12 a-clock Line, draw the Line DIE; set one Foot of your Compasses in I, and take the *nearest Distance* to the *Height of the Stile* AC, and turn that Point of your Compasses down to F, and there make a Mark in the 12 a-clock Line, on which Point F describe the *Semicircle* G I H, and divide it into 12 equal Parts, for that *Semicircle* represents *one Half* of the *Equinoctial*; lay a Ruler to F, and to those Marks in the *Semicircle* just now made, and draw Lines from thence to the Line DIE. Lastly, draw Lines from A to those Marks in the Line DIE, and they shall be the true *Hour Lines* upon your Dial's Plane.

### *For the Quarters.*

The *Quarters* are drawn in like Manner, by dividing the *Semicircle* into 48 equal Parts, so that *one Quarter* will be 3 Deg. 45 Min. *two Quarters* 7 Deg. 30 Min. and *three Quarters* will be 11 Deg. 15 Min. as you may see by Table III.

Having thus finished the *Hour Lines*, place 12 at the *End* of the Line A F, and if it is a *South Dial*, as specified above, and your Face toward it, you must place the *Morning Hours* on the *left Hand*, and the *Afternoon Hours* on the *right*, as you see done in the Figure.

### *For the Stile.*

If your Plane be large, it will be best to get an iron Rod, about the *Thickness* of your *Hour Lines*, for the *Stile*, and be sure to place it exactly over the 12 a-clock *Hour Line*, and to make an Angle with your Plane equal to the *Complement of Latitude*, which

## Chap.VI. *Of the erect direct North Dial.* 23

which is done by applying the Edge of your Quadrant to it, and so fix it, when you find it stands true.

*For the Thickness of the Stile.*

 *Be sure* you always mind to make Allowance for the *Thickness of the Rod* which is to be the *Stile*, and this is to be done when you draw the *Semicircle GIH*, by having *two Centers* at *F*, distant *just the Thickness of the Stile*; otherwise, if this Care be not taken, your Dial will go too *slow* in the *Forenoon*; and too *fast* in the *Afternoon*.

## CHAP. VI. *To make an erect direct North Dial.*

Plate 4. Fig. 1.

**T**HIS *Dial Plane* is no more than an *up-right Wall* that exactly faces the *true North Point*. This Dial is of no Use from *September* the 22d to *March* the 21st, that is, while the Sun is in the *six Southern Signs*,\* to us who inhabit the *Northern Hemisphere*, because it only shews the Time from *Sun rising* to *six* in the *Morning*, and in the *Afternoon*, from *six* till *Sun setting*; for this *Dial*, and the *South Dial*, make up the *Horizontal Dial*, *i. e.* takes in all the Hours of the *longest Day*; and as the *Stile* of the *South Dial* points down-

The Six Northern Signs are,

|               |   |               |   |
|---------------|---|---------------|---|
| <i>Aries</i>  | ♈ | <i>Cancer</i> | ♋ |
| <i>Taurus</i> | ♉ | <i>Leo</i>    | ♌ |
| <i>Gemini</i> | ♊ | <i>Virgo</i>  | ♍ |

\* The Six Southern Signs are,

|                  |   |                  |   |
|------------------|---|------------------|---|
| <i>Libra</i>     | ♎ | <i>Capricorn</i> | ♐ |
| <i>Scorpio</i>   | ♏ | <i>Aquarius</i>  | ♒ |
| <i>Sagittary</i> | ♐ | <i>Pisces</i>    | ♓ |



## 24 *Of the erect direct North Dial.* Chap. VI.

*wards*, so of the *North* the *Stile* points *upwards*, and makes an *Angle* with the *Plane* equal to the *Complement of the Latitude* of the *Place*, *i. e.* what the *Latitude* of the *Place* wants to make up 90 Deg.

The making of this is the very same as the *South Dial*; for having made choice of your *Plane*, draw the *Horizontal Line* 6, A 6, for the *East* and *West Line*; about the *Middle*, at A, erect the *Perpendicular* A B, which shall represent the 12 *a-clock Hour Line* (though the Figure 12 needs not be put to it.)

### *For the Stile's Height.*

On the *Point* A, with the *Chord* of 60 Deg. draw the *Arch* C D; take from your *Chords* the *Complement of the Latitude* of your *Place*, as suppose *York* 36 Deg. 5 Min. and set it from C to D; then draw A D for the *Stile's Height*.

### *For the Hour Lines.*

Make choice of *any Point* convenient for your *Purpose*, in the 12 *a-clock Line* A B, as the *Point* E, through which, at *right Angles* to the 12 *a-clock Line*, draw the *Line* F E G; set one *Foot* of your *Compasses* in E, and take the *nearest Distance* to the *Stile's Height* A D; set *that Distance* from E to B, so shall the *Point* B be the *Center* of the *Equinoctial*; on B, with the *Distance* B E, draw the *Semicircle* H E I, and divide it into 12 *equal Parts*; lay a *Ruler* to the *Center* B, and to *those Marks* in the *Semicircle*, and where the *Ruler* cuts the *Line* F E G, are the *Places* where the *Hour Lines* must pass, which must be drawn from the *Center* A.

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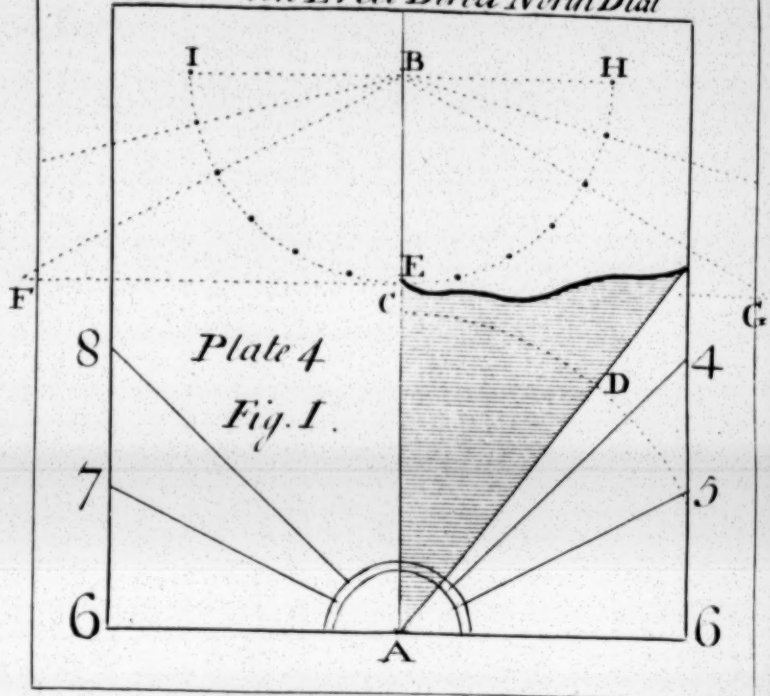
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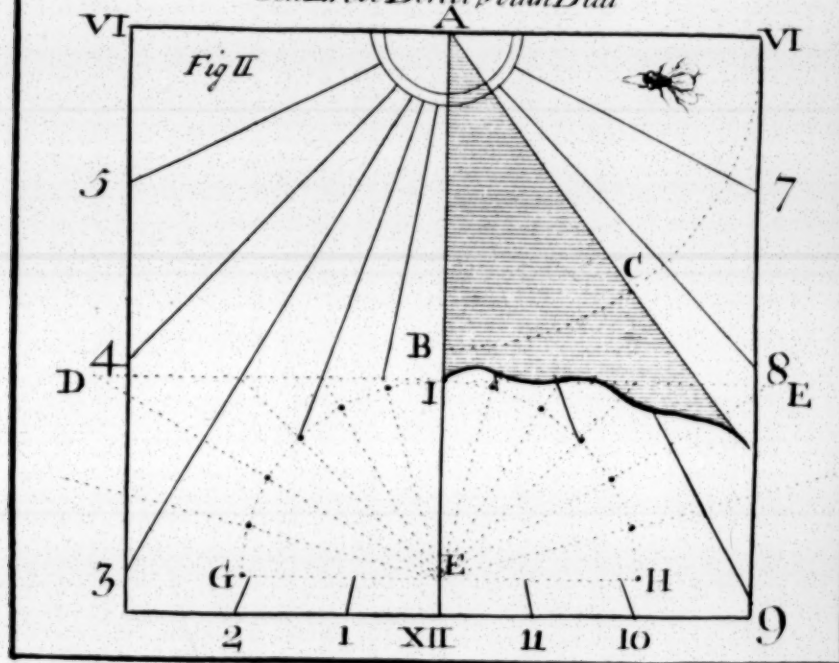
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An Erect Direct North Dial



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## Chap.VII. Of the erect direct East Dial. 25

On *this* Dial there is not any Occasion of drawing any more *Hour Lines* than 4 and 5 in the *Morning*, and 7 and 8 at *Night*.

*For the Stile.*

Over the 12 a-clock Line A B, at *right Angles*, fix the *Stile*, so that it may make an Angle with the Plane, equal to the *Complement of the Latitude of the Place*, which you must try by Help of your *Quadrant*, as has been before directed in the *South Dial*; and thus is the *North Dial* compleatly finished.

N. B. The *Quarters* and *Half Hours* are drawn as has been taught in *Pages* 20 and 22.

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## CHAP. VII. To draw an erect direct East Dial.

Plate 5. Fig. 1.

THIS Dial's Plane lieth in the Plane of the *Meridian of the Place*, i. e. is no more than an *upright Wall*, that exactly faces the *true East Point*. The *Hour Lines* are all *parallel to each other*, and to the *Axis of the World*, and consequently have *no Centers*; the Sun comes on it at his *Rising*, and continues thereon till *near Noon*.

The *six a-clock Hour Line* is the *Substilar Line*, over which the *Stile* is fixed at *right Angles*, and may be either a *thin Plate* of Iron, or a *perpendicular Wire*, &c. whose *Height* must be equal to the *nine a-clock Hour Line* in this Dial, and to the *three a-clock Hour Line* in the *West Dial*.

Having



## 26 *Of the erect direct West Dial.* Chap. VIII.

Having then made choice of your Plane, *about one third* of the Distance from the *Bottom*, draw the *Horizontal Line* ACH; in some convenient Place, as at C, draw a *Circle* with the *Chord* of 60 *Degrees* *sure*; then take the *Chord* of the *Latitude* of the Place, as suppose at *Oxford* 51 Deg. 45 Min. and set from H to P, and draw PCS, which shall be the *Substilar Line*, and *six a-clock* Hour Line, to which, at *right Angles*, draw CD for the *Equinoctial*.

Next draw the Line ASB, *parallel* to the *Equinoctial*, and divide the *Quadrant* SD into *six equal Parts*; lay a Ruler to the *Center* at C, and to those *equal Parts* in the Circle, and it will cut the Line AB in the Points where the *Hour Lines* must pass, through *which Points*, in the Line ASB, draw the *Hour Lines* *parallel* to the *six a-clock* Hour Line, which are the true *Hour Lines* from *Six* till *Noon*; the Hours of 4 and 5 in the *Morning* are the *same Distance* from 6 on one Side, as 7 and 8 are on the *other*.

The *Quarters* are drawn by subdividing the *Divisions* in the Circle into *four* equal Parts, as *has* been above directed.

### *Of fixing the Stile.*

The Hour Lines being thus drawn, fix the *Stile* at right Angles on the *Substilar Line*, as before directed, and your Dial is compleatly finished.

This Dial is universal, by placing the Earth's Axis parallel to the Axis of the World, in what Latitude soever you be.

*N.B.* The Earth's *Axis*, in this Dial, is represented by the *six a-clock* Hour Line. See the Description of the *Sphere*. See also the End of Chap. XXI.

CHAP.

CHA P. VIII. *To draw an erect direct West Dial.*

Plate 5. Fig. 2.

**T**HIS *Dial Plane* is no more than an *upright Wall* that exactly *faces the true West Point.*

The making of this is the very same, in all Respects, as making of the *East Dial*, only as the *East Hour Lines* are elevated to the *right Hand*, so here they are elevated to the *left Hand.*

The Hour of 12 can never come upon either the *East* or *West Dial Planes*, because at that Hour the Sun being upon the *Meridian*, the Shadow of the Stile will be *parallel* to the Plane, and consequently can cast no Shadow upon it.

*For the Hour Lines and Substilar Line.*

Then, having your Plane in Readiness, at about *one Third* of the Depth of the Plane *from the Top*, draw the *Horizontal Line* AH, and make choice of a *convenient Point* therein, as at C, and draw the Circle PHDS; take 50 Deg. 49 Min. from your *Line of Chords* (that being the Latitude of the City of *Exeter*) and set that Distance just now taken from your *Line of Chords*, from H to P; draw PCS for the *Substilar Line*, and *Hour of Six.* [2] And, at *right Angles* thereto, draw CD to represent the *Equinoctial*, and draw the Line BA to touch the Circle in S, *parallel* to CD. [3] Divide the Quadrant DS into *six equal Parts*, and lay a Ruler to the Center at C, and to each Mark in the Quadrant DS, and it will cut the Line BA in the Points where the *Hour Lines* are to pass. [4] Through those

*those* Marks, in the Line BA, draw Lines *parallel* to the *six a-clock Hour Line*, and they shall be the true *Hour Lines* upon the *Dial*. The Hours of 7 and 8 in the *Evening* are the *same Distance* from 6, that 5 and 4 are on the *other Side*.

*For the Quarters and Half Hours.*

The *Quarters* and *Half Hours* are drawn in both these *East* and *West Dials*, by *dividing* each *sixth Part* of the *Quadrant DS* into *four equal Parts*, and carrying them into the *Line AB*, by laying the *Ruler* to the *Center C*, and to *those Parts* in the *Arch DS*, as you were taught in drawing the *Hour Lines*.

*For fixing the Stile.*

Fix the *Stile* upon the *six a-clock Hour Line*, and at *right Angles* thereto, which may be a *Plate of Copper, Brass or Iron*, as in *Plates 5 and 6*, whose *Height* must be *equal* to *CD*, or the *three a-clock Hour Line*, and then is your *Dial* finished.

*See also the End of Chapter XXI.*

## CHAP. IX. *To make a Polar Dial.*

### Plate 6.

**T**HIS Dial is called by some Authors an *Equinoctial Dial*, and by others a *Polar Dial*; but, be that as it will, it is plain, that all Places lying under the *Equinoctial* have *no Latitude*; as for Instance, the *Island of St. Thomas* has *no Latitude*,



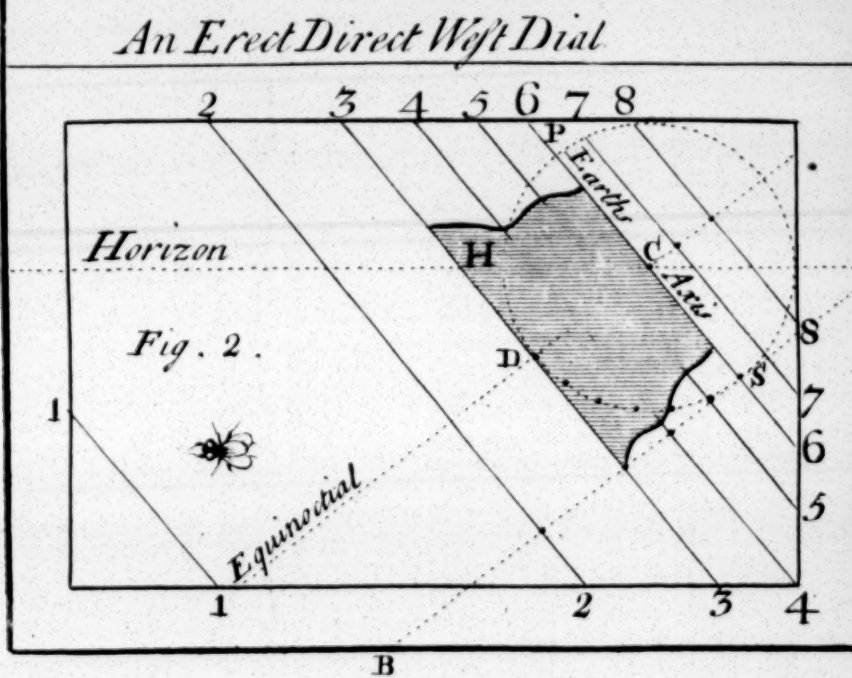
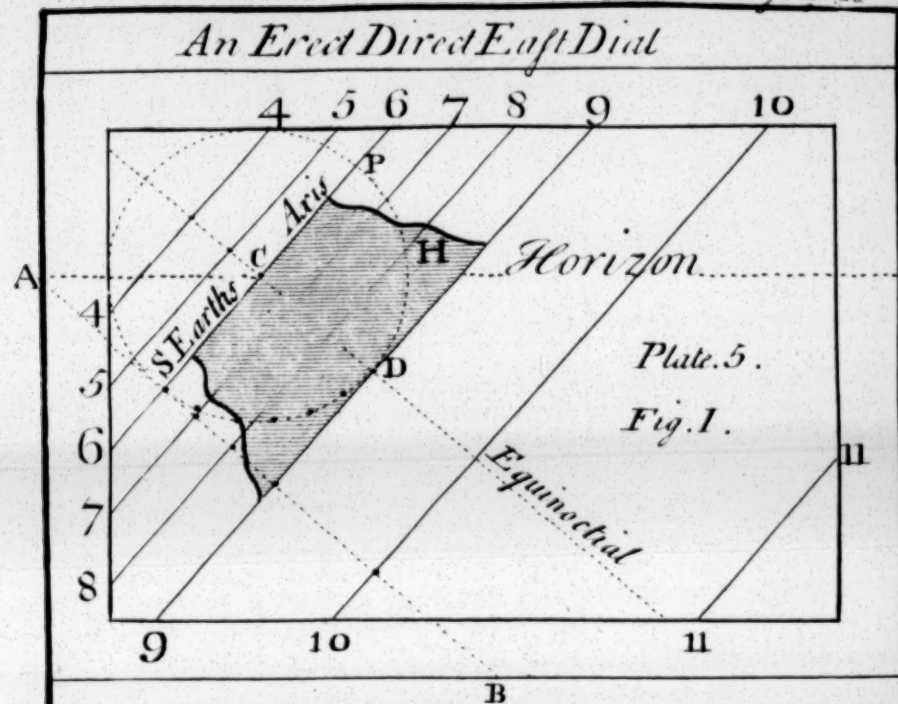
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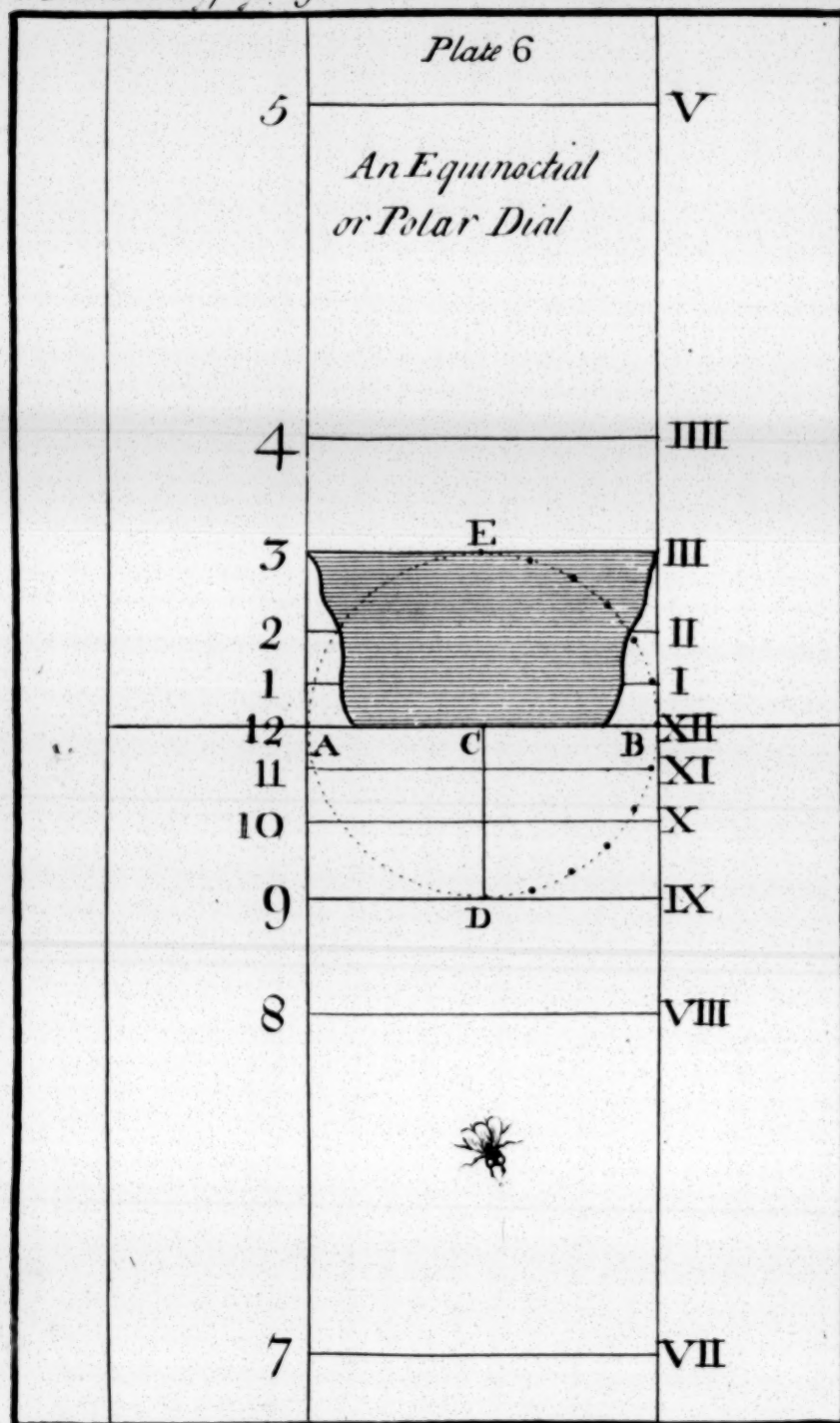
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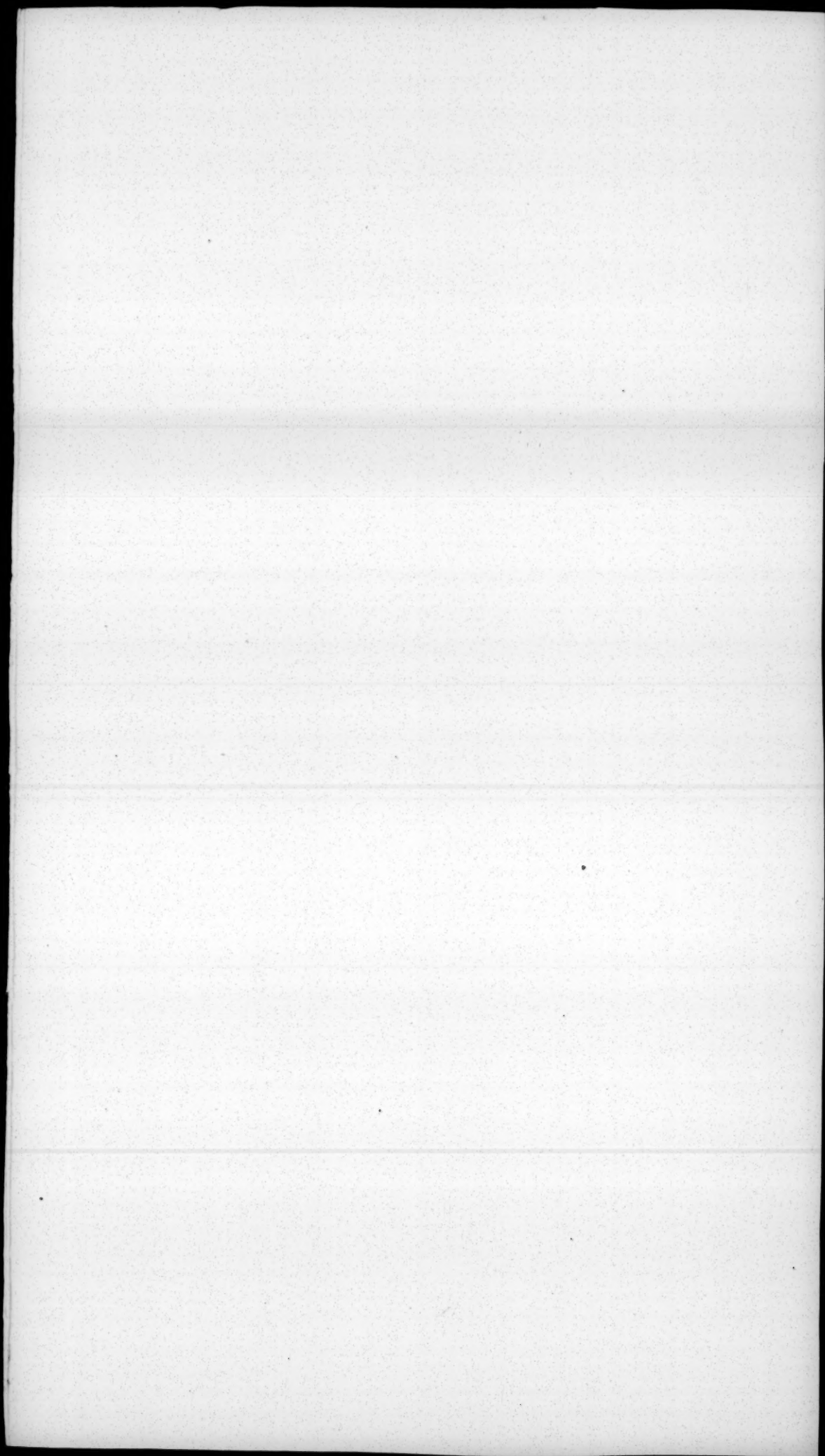












tude, for which this *Dial* is made, and for that Reason the *Hour Lines* cannot have any *Center*; and therefore all the *Hour Lines* drawn upon these *Dials* will be *parallel* to each other.

*For the Hour and Substilar Lines.*

 [1] To draw the *Hour Lines* upon this Plane, first draw AB for the *Substilar Line* and *Hour Line* of XII. [2] On C, as a *Center*, with the *Chord* of 60 Deg. draw the *Circle* AEBD, and draw the two Lines V VII, and 5. 7. divide the *Semicircle* EBD into 12 equal *Parts*; lay a *Ruler* to the *Center* of the *Circle* at C, and to each *Mark* in the *Circle*, and it will cut the Line V VII in the *Points* where the *Hour Lines* must pass. [3] *Through* which *Points* draw *Hour Lines* *parallel* to A B, and they shall be the *true Hour Lines* that were required.

*For the Stile.*

The *Stile* may be a broad Plate of *Copper*, *Brass* or *Iron*, at Pleasure, placed at *right Angles* over the 12 a-clock *Hour Line*.

The *Hour Line* of six never falls upon this *Dial*, because under the *Equinoctial* the Sun rises and sets at Six the Year throughout, with very little Variation.

30 *To find the Declination of a Wall.* Chap.X.

CHAP. X. *To find the Declination \* of a Wall or Plane whereon to draw a Sun-Dial.*

Plate 7. Fig. 9.

*A Description of the Instrument.*

[1] **P**ROCURE an oaken Board (which at *London* they call *Wainscot*) about a Foot square, more or less, it matters not; take *ABCD*, about an Inch thick, well plained on both Sides, and thereon paste a Sheet of good Paper very smooth, on which draw *two* or *three concentric* Circles, it matters not how many, nor at what Distance they be. [2] In the *Center I*, let there be an Hole to receive a *streight Wire* to screw up and down at Pleasure, and to stand at *right Angles* to the Board itself; draw *two* Diameters, and mark them with the Letters of the four *cardinal Points*, *East*, *West*, *North* and *South*, which *Line NS* represents the *Axis* of the *Wall*, *i. e.* it stands *perpendicular*, or at *right Angles*, to the *Wall itself*; and if it doth not decline from the *South* or *North*, nor yet to the *East* or *West*, the said *Line* also represents the *12 a-clock Hour Line*.

*How to take the Declination.*

[3] When you would take the *Declination* of a *Wall*, apply the *Edge* of the Instrument *AB* to the *Wall*; and in the *Forenoon*, the *Sun* shining, by the Help of your *Quadrant* place the Instrument parallel to the *Horizon*; screw up your *perpendicular*,

\* See Page 21, Note 4:



## Chap. XI. Of Declining Dials.

31

*Pin* in the *Center* till the *Shadow* of its *Top* touch any of the *Circles*, it matters not which, as suppose the *outmost* at *F*; let all Things now rest till *Afternoon*. [4] And then carefully observe where the *Top* of the *Shadow* toucheth the *same Circle* again, which we will suppose at *G*: thus is your *Observation* finished. [5] Take your *Instrument* down, and with your *Compasses* divide the *Arch* *FG* into two equal Parts in *H*, and if from *H* you draw a *Line* through the *Center*, it shall be a true 12 a-clock *Hour Line*; and *NH* is the *Declination of the Wall*, which, by applying it to the *Line of Chords*, I find to be 14 Deg. And when the *Mark*, last found at *H*, falls on the *East Side* of the *Line NS* (as this doth) then is the *Declination of the Wall East*; but when the *Mark* falls on the *West Side*, then the *Declination* is *West*.

*Note*, The *Curve*, that the *Top* of the *Pin* describes, is always an *Hyperbola*, whether it be perpendicular, or incline to the *Horizon*; and such are also the *Parallels* of the *Sun's Declination* when put upon a *Dial*.

## CHAP. XI. To make an erect Declining Dial.

THE *upright* or *erect* *Dial Planes* already treated of, are such as did directly face the *four cardinal* or principal Points of the *Horizon*, viz. *East*, *West*, *North* and *South* Points. NOW ALL OTHER *upright* or *erect* *Dial Planes* are said to *decline*,\* and their *Declination* is counted from the *North* or *South*, towards *East* and *West*, and those *Planes* are called *South* or *North* erect *Planes declining East* or *West*.

\* See Page 21, Note 4.

## Plate 7. Fig. 2.

Let it be required to make a Dial in the *Latitude* of 53 *Deg.* 25 *Min.* North, declining from the South to the West 21 *Deg.* 10 *Min.* viz. for *Liverpool*, *Warrington* or *Cronton* in *Lancashire*.

First, *For the Distance of the Substilar Line from the 12 a-clock Hour Line.*

[1] Draw the *Horizontal Line* AB, and from C let fall *perpendicular* the 12 a-clock Hour Line CD, and from the *Line of Chords* take 60 *Deg.* with your *Compasses*, and set one Foot of your *Compasses* in C, and draw the *Semicircle* ADB. [2] And then draw CD at *right Angles* to AB, for the 12 a-clock Line. [3] Take the *Complement* of the *Latitude* 36 *Deg.* 35 *Min.* from your *Line of Chords*, and set it from D to E, and draw EF *parallel* to AB, so is FE the *Sine* † of the *Arch* DE. This done, [4] take in your *Compasses* the *Plane's Declination* 21 *Deg.* 10 *Min.* from your *Line of Chords*, and set it from D to G, and draw CG. [5] Take EF in your *Compasses*, and set it from C to H; draw HI *parallel* to AB. [6] Take HI and set from F to L, and draw CLM; now DM measured on your *Line of Chords* is 15 *Deg.* 2 *Min.* the Distance of the *Substilar Line* from the 12 a-clock Line.

Secondly, *For the Stile's Height.*

[1] From the Point H draw the Line HK *parallel* to CD the 12 a-clock Line. [2] Then take

† The *Sine* of an *Arch* is a Line drawn from any Point of the *Circumference* of a Circle to that Line that passes through the Center of the said Circle.

HK

## Chap. XI. Of Declining Dials. 33

H K in your Compasses, and set it from L to N, and draw C N for the *Top of the Stile*; [3] Then shall M N measured on your *Line of Chords* be 31 Deg. 49 Min. the *height of the Stile*.

Thirdly, *For the difference of Inclination\* of Meridians.*

[1] Set one Foot of your Compasses in M, and take the *nearest distance* to E F. *This Distance* set upon the 12 a-clock Line from F to O. [2] Then take the *distance* from O to G, and set it from O to P. [3] Take the *distance* P M in your Compasses, and measure it on your *Line of Chords*, and you will find it to be 25 Deg. 46 Min. the *Inclination of Meridians* sought: This 25 Deg. 46 Min. reduced into Time (by the *Table III*) is 1 Hour, 43 Min. 4 Seconds, by which I see that the *substilar Line* will fall *between the Hours* of one and two a-clock in the *Afternoon*.

Lastly, *For the Hour Lines.*

[1] In any *convenient Place in the Substilar Line* (according to the *Largeness* of your Dial Plane) as at M, draw the Line R S at *right Angles* to the *Substilar Line* C M, [2] Set one foot of your Compasses in M, and take the *nearest distance* to C N the *Stile's height*, [3] One foot resting in M, turn the other to q in the *Substilar Line*, upon q as a *Center*, with the *distance*

\* See Plate 7. Fig. 1. in which H I represents the 12 a-clock Hour Line in that Place, and N S is the Line that is *perpendicular to the Plane*; now the *Angle* that is made between these two Lines at I, is what in Dialing is called the *Inclination of Meridians*, and is an *Arch* of the *Equinoctial*, comprehended between the *Meridian* of the *Plane* and the *Meridian* of the *Place*, and shews in what *Longitude* from the *Meridian* of the *Plane* it will become an *Horizontal Dial*.

D

q M,



q M, draw *the Circle* as you see done in the Dial, which represents the *Equinoctial*.

[4] Lay a Ruler from *the Center* at q to D (that is the Place where the *Line RS* cuts the 12 *a-clock Hour Line*) and then the Ruler doth cut the *Equinoctial* in a Point *near O*, where you are to begin to divide it into 24 *equal Parts*, which I have here marked with little *Dots*. [5] Lay a Ruler to the *Center* at q, and to *every one* of the *equal Divisions* in the *Equinoctial*, and where the Ruler cuts the *Line RS*, make these marks \*\*\* *Lastly*, draw Lines from the *Center* of the Dial at C to these marks \*\*\* in the *Line RS*, and those are the true *Hour Lines* upon the Dial, to which place the proper Figures to *every Hour*, as you see done in the *Scheme*.

### Of the hanging of the Stile.

The *Stile CN* must hang *directly Squarewise* with the *Substilar Line CL*, and this you must try with your *Quadrant*, thus; place *that edge* of your *Quadrant* upon which *the Sights are*, to the *Top of the Stile*, and when the *Thread* cuts the *Limb* of the *Quadrant* in the *same Degree* with the *Latitude of the Place*, then it is *right*, otherwise it is *wrong*.

Note, Now you have finished your Dial, and in so doing, you have in the making of this one made four Dials, viz.

|                        | Deg. | Min.  |
|------------------------|------|-------|
| A South Declining East | }    | 21 10 |
| A South Declining West |      |       |
| A North Declining East |      |       |
| A North Declining West |      |       |

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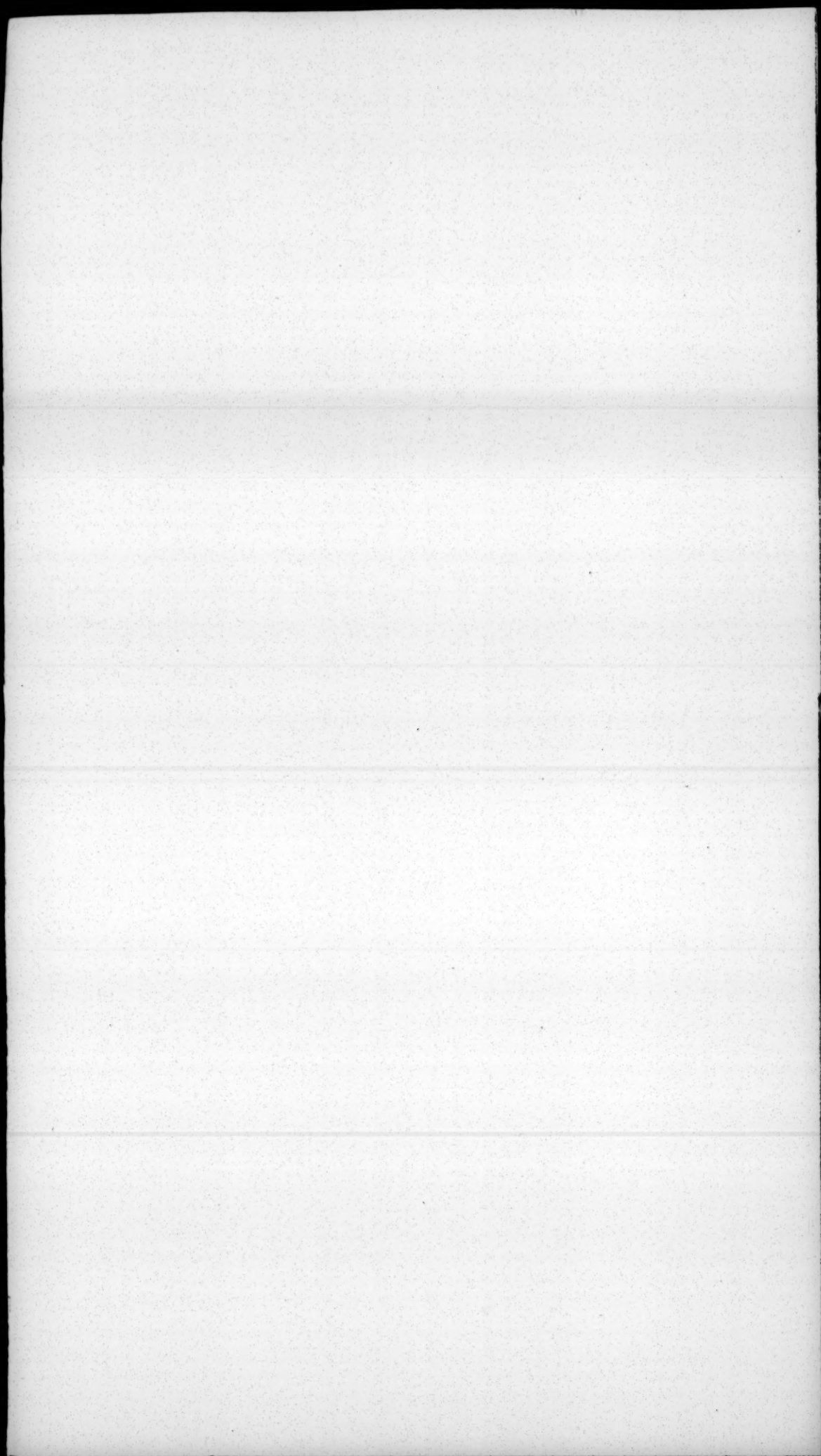
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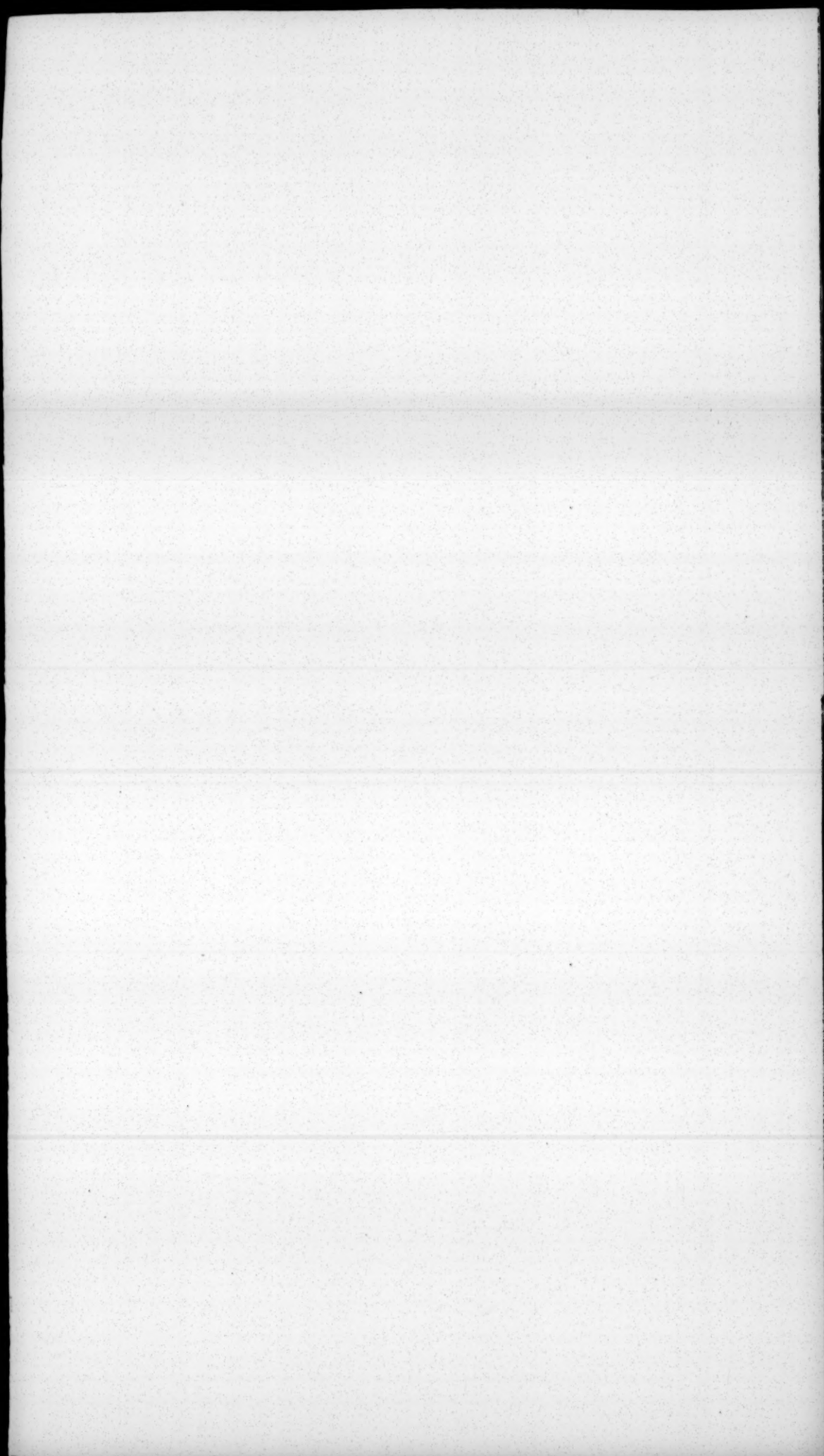
But you must change the *Names* of the *H urs*, viz. 10 into 2, 9 into 3, 8 into 4, &c.† and place the *Stile* on the *contrary Side* of the 12 a-clock *Line* for the *South* declining *East*, and by turning the *Dial up-side downwards*, for the *North Decliners*, so that the *Stile* may point *upwards* to the *North Pole*, and the *Hours* about midnight omitted, as your own Reason will soon direct you.

☞ Here you are to take notice, that if the *Plane* decline 60 *Deg. or more*, then the *Hour Lines* having *Centers* will be so near together, and the *Stile* will then be so near the *Plane*, that *one* thing will much discommode *another*, and make it a great difficulty to shew the *true Hour* of the *Day* thereby; therefore they ought to be removed *far* from the *Center*, that they may become *wide enough* to answer the end of shewing distinctly the *true Hour* of the *Day*.

But still here will arise a Difficulty in *dividing the Circle*, which represents the *Equinoctial*, for there will be required the Difference of the *Inclination of Meridians* of the *Plane* and *Place*; for this Purpose I have added *Table V*, for the *Latitude* of *London*, shewing the *Stile's height*, *Substile's distance* from the *Meridian*, and difference of *Inclination of Meridians*, which tho' calculated indeed for the *Latitude* of *London*, (viz. 51 *Deg.* 32 *Min.*) yet may serve indifferently

† And here you are to observe that it is *not the Stile* that changes its *Place* or *Position*, but the *Plane itself*; for the *Stile* answering to the *Latitude of the Place*, it remains *always steady* and the same in *all Declinations*: so that if you conceive a *Plane* declining (as in the *Example* now before us) 21 *Deg.* 10 *Min.* to the *Westward*, the *Subsilar Line* falls betwixt the *Hours* of *One* and *Two* in the *Afternoon*; and supposing the same *Plane* to move to the *Eastward* 21 *Deg.* 10 *Min.* the *Subsilar Line* will then fall betwixt the *Hours* of *Ten* and *Eleven* in the *Morning*. For it is an *infallible Rule*, that if the *Plane* declines *Eastward*, the *Subsilar Line* falls amongst the *Morning Hours*, but if *Westward* amongst the *Afternoon Hours*.





But you must change the *Names* of the *Hours*, viz. 10 into 2, 9 into 3, 8 into 4, &c.† and place the *Stile* on the *contrary Side* of the 12 *a-clock Line* for the *South* declining *East*, and by turning the *Dial upside downwards*, for the *North Decliners*, so that the *Stile* may point *upwards* to the *North Pole*, and the *Hours* about midnight omitted, as your own Reason will soon direct you.

☞ Here you are to take notice, that if the *Plane* decline 60 *Deg. or more*, then the *Hour Lines* having *Centers* will be so near together, and the *Stile* will then be so near the *Plane*, that *one* thing will much discommode *another*, and make it a great difficulty to shew the *true Hour* of the *Day* thereby; therefore they ought to be removed *far* from the *Center*, that they may become *wide enough* to answer the end of shewing distinctly the *true Hour* of the *Day*.

But still here will arise a Difficulty in *dividing the Circle*, which represents the *Equinoctial*, for there will be required the Difference of the *Inclination of Meridians* of the *Plane* and *Place*; for this Purpose I have added *Table V*, for the *Latitude* of *London*, shewing the *Stile's height*, *Substile's distance* from the *Meridian*, and difference of *Inclination of Meridians*, which tho' calculated indeed for the *Latitude* of *London*, (viz. 51 *Deg.* 32 *Min.*) yet may serve indifferently

† And here you are to observe that it is *not the Stile* that changes its *Place* or *Position*, but the *Plane itself*; for the *Stile* answering to the *Latitude of the Place*, it remains *always steady* and the same in *all Declinations*: so that if you conceive a *Plane* declining (as in the *Example* now before us) 21 *Deg.* 10 *Min.* to the *Westward*, the *Subsilar Line* falls betwixt the *Hours* of *One* and *Two* in the *Afternoon*; and supposing the same *Plane* to move to the *Eastward* 21 *Deg.* 10 *Min.* the *Subsilar Line* will then fall betwixt the *Hours* of *Ten* and *Eleven* in the *Morning*. For it is an *infallible Rule*, that if the *Plane* declines *Eastward*, the *Subsilar Line* falls amongst the *Morning Hours*, but if *Westward* amongst the *Afternoon Hours*.

36 *Of a great Declining Dial.* Chap. XII.

for most Places in *England*, but he that wants to be more curious and exact, may, by observing the Directions given in the beginning of this Chapter for finding the *three Requisites*, (by that means) obtain *those Requisites* for any Place in the known World.

CHAP. XII. *To make a Dial upon a Plane when the Pole has but a small Elevation above the Plane.*

Plate 8. Fig. 1.

I Shall take for *an Example* a Dial that I made at *London*, whose Plane *declined* from the *South* by the *East*, *northerly* 100 Deg. 16 Min. that is 79 Deg. 44 Min. from the *North* towards the *East*.

*For the Stile's height.*

 The *Stile's height* you will find by *Construction*, as in Chap. X. or by *Table V.* to be 6 Deg. 22 Min. the *Substile's distance* from the *Meridian*, 38 Deg. 1 Min. the *Inclination of Meridians*, 81 Deg. 56 Min.

[1] Let the *Square ABCD* represent the Plane, because 'tis a *North Plane declining Eastward*, therefore the *Stile* must point *upwards*, and the *Center* of the *Hour Lines* will be *some where below* the Plane itself.\* And therefore take 60 Deg. from your *Line of Chords*. Set one Foot of your *Compasses* at the *bottom Corner* of the Plane at *C*, and draw the *Qua-*

\* If the Plane had been 79 Deg. 44 Min. from the *South* to the *East*, or *West*, then the *Stile* must have pointed *downwards*, towards the *South Pole*, and the *Center* of the Dial would have been *some where above* the Plane itself.

*drant*



Chap.XII. *Of a great Declining Dial.* 37

drant E F. [2] Take 38 *Deg.* 1 *Min.* from your *Line of Chords*, (the *Substile's* distance from the 12 *a-clock Line*) and set it from F to G, then draw CG continued for the *Substilar Line*. [3] Take 6 *Deg.* 22 *Min.* the *Stile's height* from your *Line of Chords*, and set it from G to H, and draw CH for the *Stile*: [4] Now, because the *Stile* has but *small height*, draw an *other Line* IK *parallel* to the *height* or top of the *Stile* of the *Dial*, at such *convenient* distance as in your judgment will best fit the *Dial Plane*, viz. that all the *Hour Lines* may fall thereon, so shall that *Line* IK be the *enlarged Stile* of the *Dial*.

*For the Hour Lines.*

[5] Now by the *Substilar Line*, and this *enlarged Stile*, the *Hour Lines* may be drawn (at *convenient* distances) without any regard had to the *Center* of the *Dial*.

And to do that, assume any *two Points* in the *Substilar Line* CG, at some *convenient* distance from each other, as L and M, and through those *two Points* draw *two streight Lines*, both of them at *right Angles* to the *Substilar Line* CG, as the *Lines* NLO and PMQ. [6] Set one foot of the *Compasses* in L, and take the *nearest* distance to the *enlarged Stile* IK, and turn that foot from the *Stile* to R; on R as a *Center* with the distance LR draw a *Semicircle*, set one foot of the *Compasses* in M, and take the *nearest distance* to the *enlarged Stile* IK, and turn that foot from the *Stile* to S; on S, as a *Center*, draw a *Semicircle*.

[7] Take the *Plane's Inclination of Meridians*, 81 *Deg.* 56 *Min.* and set from L to T, and from M to V upon the *Semicircles*.† Then

† You must make the *Radius* LT, and MV, severally the *Radius* of a *Line of Chords*, when you set off the *Inclination of Meridians*.

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[8] Divide *each Semicircle* into 12 *equal Parts*, beginning at T and V; lay a Ruler to the *Centers* R and S *severally*, and to the *Marks* just now made in the *Semicircles*, and the Ruler will then cut the *Lines* PMQ and NLO in the true Places where the *Hour Lines* must be drawn.

*Lastly*, Lay a Ruler to *those Marks* in the *Lines* PMQ and NLO, and draw *right Lines* through the *Plane*, and they shall be the *true Hour Lines* required, and will be removed far enough from the *Center*, and that will shew distinctly the Hour of the Day.

### *For the Stile.*

The *Stile* must stand at *right Angles* upon the *Substilar Line* IK. And must be placed as near to the widest distance of the *Hour Lines* as possible; because the wider the *Hour Lines* are, the better may the Hour of the Day be discovered.

### *For the Quarters.*

The *Quarters* are drawn by dividing *each* of the 12 *equal Parts* in the *Semicircles* into *four equal Parts more*, and from *those Divisions* draw *Lines*, as has been taught above for drawing the *Hour Lines*, and your Dial is finished.

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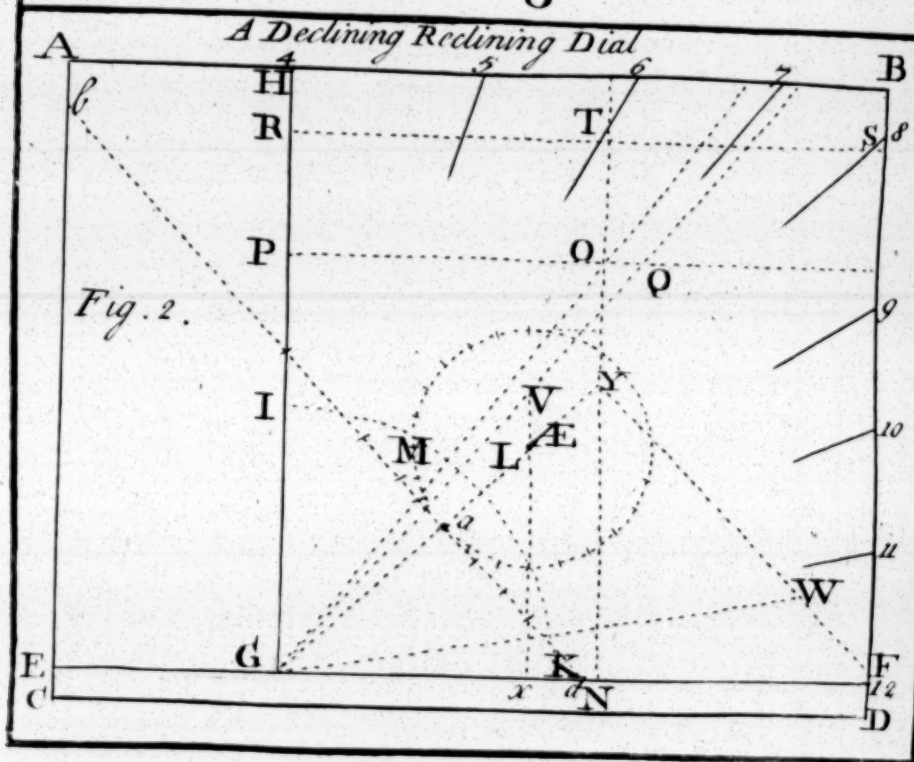
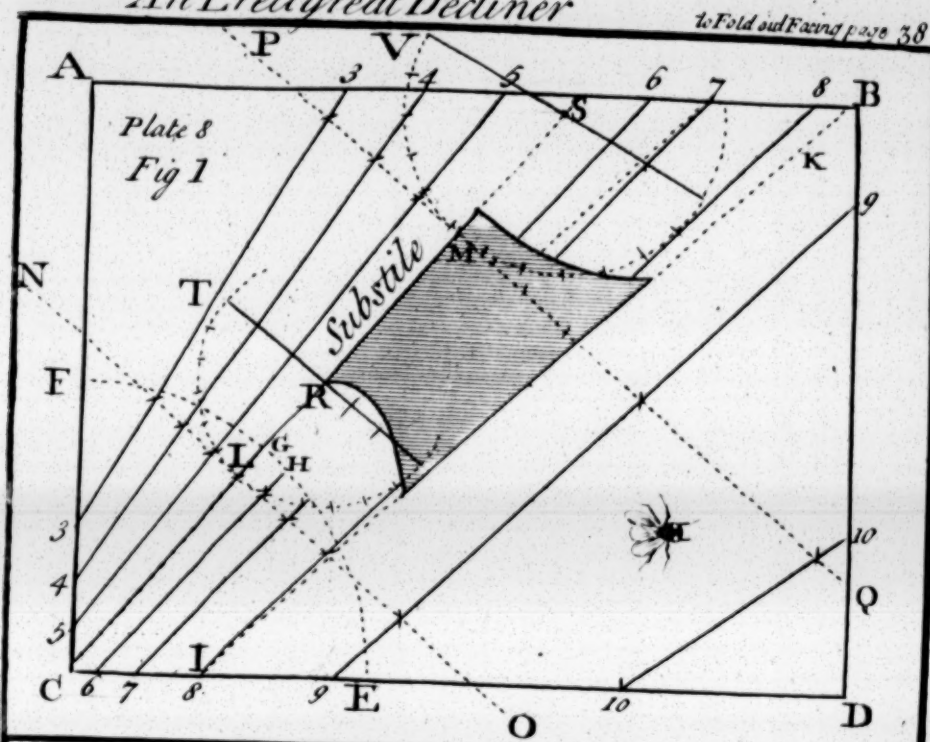
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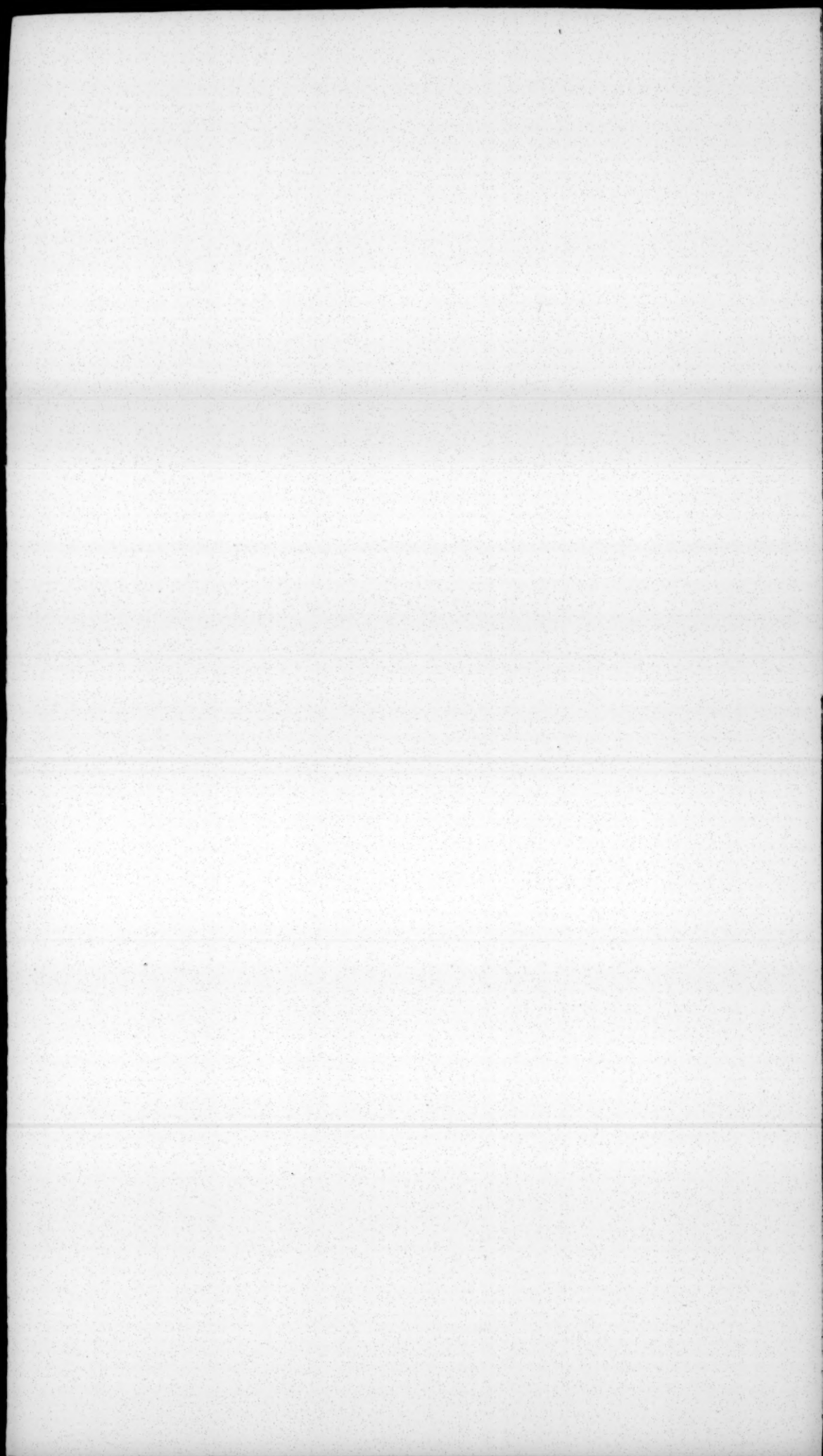


# An Erect great Decliner

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CHAP. XIII. *To make a declining reclining\* Dial.*

Plate 8. Fig. 2.

**S**UCH Planes as do directly face the *South* or *North Points* of the *Horizon*, but do *recline* (or fall backwards) from the *Zenith* (like the Roof of a House) towards the *South* or *North*, are called *South* or *North Direct Planes*, *reclining* so many *Degrees* as the *Reclination* is; and the Number of *Degrees* that the Plane *reclines*, may be found by applying the *edge* of your *Quadrant*, in which the *Sights* are placed to the *Plane*, and the *Thread* will cut the *Limb* in the Number of *Degrees* that the Plane *reclines*, which being a Thing so plain, I need not give any Example.

And of *reclining Planes* there are *six* Varieties, *three* of *South*, and *three* of *North Recliners*, all which may be reduced to *new Latitudes*, wherein they will become *Horizontal Planes*, and consequently Dials may be made as has been taught, Chap. IV. where I have shewn how to draw *Hour Lines* upon an *Horizontal Plane*.

*First of Direct South Recliners.*

*First Variety:* Let there be a *direct South Plane* in the *Latitude* of *Cambridge*, which is *52 Deg. 12 Min.* which *reclines* from the *Zenith* thereof *26 Degrees*; in what *Latitude* will that be an *Horizontal Plane*?

\* Those *Dial Planes* that *lean from you* when you stand before them, are called *reclining Planes*, because they *recline* from the *Zenith*.

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Now, because the *Reclination* is *less* than the *Complement* of the *Latitude* 37 Deg. 48 Min. *Subtract* the *Plane's Reclination* 26 Deg. from the *Complement* of the *Latitude* 37 Deg. 48 Min. and the *Remainder* 11 Deg. 48 Min. is the *new Latitude* in which it becomes an *Horizontal Plane*.

## *The Operation.*

|                                                                     |   | Deg. | Min. |
|---------------------------------------------------------------------|---|------|------|
| The <i>Complement</i> of the <i>Latitude</i> at <i>Cambridge</i> is | — | 37   | 48   |
| The <i>Plane's Reclination</i> there (which <i>subtract</i> ) is    | — | 26   | 00   |
| <hr/>                                                               |   |      |      |
| The <i>new Latitude</i> is                                          | — | 11   | 48   |

So that an *Horizontal Dial* made for the *Latitude* of 11 Deg. 48 Min. shall be a *South Recliner* 26 Degrees in the *Latitude* of *Cambridge*.

*Second Variety.* If the *Reclination* of the *Plane* be equal to the *Complement* of the *Latitude* of the *Place*, the *new Latitude* is *nothing*, that is, neither *Pole* has any *Elevation* above such a *Plane*, and the *Hour Lines* are all *parallel*, and the *Stile* is likewise *parallel* to the *Plane* itself; and therefore, a *Dial* for such a *Plane* must be made in *all respects*, as has been shewn *Chap. IX. Plate 6.*

So that admit at *Lincoln*, where the *Latitude* is 53 Deg. 13 Min. a *South Plane* *reclines* from the *Zenith* 36 Deg. 47 Min. (which is equal to the *Complement* of the *Latitude* of that City) I say, it becomes an *Horizontal Dial* under the *Equinoctial*, as appears by the *Operation*.

## *The Operation.*

|                                                                   |   | Deg. | Min. |
|-------------------------------------------------------------------|---|------|------|
| The <i>Complement</i> of the <i>Latitude</i> at <i>Lincoln</i> is | — | 36   | 47   |
| The <i>Plane's Reclination</i> there (which <i>subtract</i> ) is  | — | 36   | 47   |
| <hr/>                                                             |   |      |      |
| So you see the <i>new Latitude</i> is                             | — | 00   | 00   |

In *Plate 6.* you have the *Dial* that is for this Purpose.

# Chap.XIII. Declining Reclining *Dials*. 41

*Third Variety.* If the *Reclination* of the Plane exceeds the *Complement of the Latitude of the Place*, then *subtract* the *Complement of the Latitude* from the *Plane's Reclination*, and the *Remainder* is the *new Latitude*, where it will become an *Horizontal Plane*.

## Example.

Suppose at *Norwich*, whose *Latitude* is 52 Deg. 42 Min. a *direct South Plane* reclining 56 Deg. from the *Zenith*, where will that be an *Horizontal Dial*?

## The Operation.

|                                                                       | Deg.  | Min. |
|-----------------------------------------------------------------------|-------|------|
| The Plane's <i>Reclination</i>                                        | —     | —    |
| <i>Complement of the Latitude of Norwich</i> (which <i>subtract</i> ) | —     | —    |
|                                                                       | 56    | 00   |
|                                                                       | 37    | 18   |
|                                                                       | <hr/> |      |
| The <i>New Latitude</i> is                                            | —     | —    |
|                                                                       | 18    | 42   |

So that an *Horizontal Dial* made for the *Latitude* of 18 Deg. 42 Min. will be a *direct South* reclining *Dial* from the *Zenith* of *Norwich* 56 Deg.

## Secondly, Of *Direct NORTH* Recliners.

*First Variety.* If the *Reclination* be less than the *Complement of the Latitude of the Place*, add them together, and that is the *new Latitude* where such *Recliner* will become an *Horizontal Plane*.

## Example.

Suppose at *Newcastle upon Tyne*, whose *Latitude* is 55 Deg. 1 Min. a *direct North Plane* should recline from the *Zenith* 29 Deg. how must the *Hour Lines* be drawn thereon?

To



## 42 Of direct North and South Chap.XIII.

To the *Complement of the Latitude of Newcastle upon Tyne*, 34 Deg. 49 Min. add the *Plane's Reclination* 29 Deg. and their *Sum* is 63 Deg. 49 Min. and that is the *new Latitude*, for which Place make an *Horizontal Dial*, as has been before taught, and that will be a *North reclining Dial* at the Place above-mentioned.

### The Operation.

|                                                                        | Deg. | Min.  |
|------------------------------------------------------------------------|------|-------|
| The <i>Complement</i> of the Latitude at <i>Newcastle upon Tyne</i> is | —    | 34 49 |
| The <i>Plane's Reclination</i> there (which add) is                    | —    | 29 00 |
|                                                                        |      | — — — |
| The <i>new Latitude</i>                                                | —    | 63 49 |

*Second Variety.* If the *direct North Plane recline equal* to the *Latitude of the Place*, add it to the *Complement of the Latitude*, and that *Sum* will always be 90 Deg. so that *under the Pole* it becomes an *Horizontal Dial*; make a Dial as has been taught in Chap. III. Plate 3. Fig. 1. by dividing a Circle into 24 equal Parts, and fixing a Wire *perpendicular* in the *Center*, and it is done.

### Example.

Suppose at *Wrexham* in *Denbighshire*, whose Latitude is 53 Deg. 2 Min. a *direct North Plane* reclines 53 Deg. 2 Min. I desire to know *where* this will become an *Horizontal Plane*?

### The Operation.

|                                                            | Deg. | Min.  |
|------------------------------------------------------------|------|-------|
| The <i>Complement</i> of the Latitude at <i>Wrexham</i> is | —    | 36 58 |
| The <i>Plane's Reclination</i> there (which add) is        | —    | 53 02 |
|                                                            |      | — — — |
| The <i>new Latitude</i> is                                 | —    | 90 00 |

Lastly,

## Chap. XIII. Declining Reclining *Dials*. 43

*Lastly*, If the Plane's *Reclination* exceed the *Complement of the Latitude of the Place*, add them together, and *that Sum* is the *new Latitude* where such a *Plane* will become an *Horizontal Plane*.

But note, if the *Sum* exceed 90 *Deg.* take the *Complement* thereof to a *Semicircle*, or 80 *Deg.* and the *Remainder* is the *new Latitude*, where such a *Reclining Plane* will become *Horizontal*.

### *Example.*

Suppose at *Shrewsbury*, whose *Latitude* is 52 *Deg.* 42 *Min.* a *direct North Plane* *reclines* from the *Zenith* 60 *Deg.* where will it become an *Horizontal Plane*?

To the *Complement of the Latitude of the Place* 37 *Deg.* 18 *Min.* add the *Plane's Reclination* 60 *Deg.* and *their Sum* is 97 *Deg.* 18 *Min.* whose *Complement* to 180 *Deg.* is 82 *Deg.* 42 *Min.* in which *Latitude* such a *Plane* at *Shrewsbury* will become *Horizontal*; therefore draw *Hour Lines* thereon, as you have been taught in making the *Horizontal Dial*, and they will be the true *Hour Lines* for that *Plane* and *Place*, as just now mentioned.

### *The Operation.*

|                                                                               |   |   |   | Deg. | Min. |
|-------------------------------------------------------------------------------|---|---|---|------|------|
| The <i>Complement</i> of <i>Latitude</i> at <i>Shrewsbury</i> is              | — | — |   | 37   | 18   |
| The <i>Plane's Reclination</i> there (which add) is                           | — | — | — | 60   | 00   |
|                                                                               |   |   |   | —    | —    |
| The <i>Sum</i> (which is to be <i>subtracted</i> from the <i>Semicircle</i> ) | — |   |   | 97   | 18   |
|                                                                               |   |   |   | —    | —    |
| A <i>Semicircle</i> is (180 <i>Degrees</i> )                                  | — | — | — | 180  | 00   |
| The <i>Sum</i> as above to be <i>subtracted</i>                               | — | — | — | 97   | 18   |
|                                                                               |   |   |   | —    | —    |
| The <i>new Latitude</i>                                                       | — | — | — | 83   | 42   |

*Note*, That in making of any of these *North* or *South reclining Dials*, you have also made (at the same Time) a *direct North* or *South inclining Dial* from the *Zenith*, 26 *Deg.*

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As in the *first Variety* for *Cambridge*, you have made also a *North Dial* inclining to the *Horizon* 26 *Deg.* either by drawing of the *Hour Lines* and *Style* through the *Center*, or by turning the *reclining Dial* about, upon the *Hour Line* of *Six*; and then as the *North Pole* is raised or elevated upon the *South Recliner*, so much will the *South Pole* be raised or elevated above the *North Incliner*.

### CHAP. XIV. To make an East or West Reclining \* Dial.

AS all *North* and *South reclining Dial-Planes*, were reduced to *new Latitudes*, wherein they would become *Horizontal Planes*; and thereby made by the *Directions* given in *Chap. IV.* so all *DIRECT East* or *West Reclining Dial Planes* in *any Latitude*, may be reduced to *erect* or *upright DECLINING Planes* in *another Latitude*, and therefore may be made by the *Directions* in *Chap. XI.* of this *Treatise*; yet I shall here shew, for the young *Tyro's* Improvement, how they may be done *mechanically*, without any such *Alteration*. But first, to reduce them to *new Latitudes*.

\* As in *upright* or *erect Dial Planes* there were two *Sorts of Varieties*, viz. *Erect direct* and *erect Declining*; so there are two *Sorts of Varieties* of *Reclining Dial Planes* likewise; for such *Reclining Planes* as do directly face either the true *East, West, North, or South* Points of the *Heavens* are called *DIRECT Reclining Planes*.

Again, those *Reclining Planes* which do not directly face the said *Cardinal Points*, but deviate therefrom, i. e. face some other Points situate between them, as *South-East, North-West, North-East*, are called *DECLINING Reclining Planes*, and the manner of drawing the *Hour Lines* upon these *Direct* and *Declining Reclining Planes*, affords a much greater Variety than there was in the *erect* or *upright Planes*. See Page 20.

The



## Ch.XIV.Of East or West Reclining Dials. 45

### The Rule.

The *Complement* of the *known Latitude*, or *Latitude you are in*, is always the *new Latitude*, and the *Complement* of the *Reclination*\* is always the *Declination* in that *new Latitude*, in which it will become an *erect declining Plane*.

And before I proceed any further, it is proper to inform you how you shall know whether the *North* or *South Pole* is *elevated* above any given Plane.

[1] All *Horizontal Planes* in *North Latitude* have the *North Pole* elevated; but all *Horizontal Planes* in the *South Latitude* have the *South Pole* elevated.

[2] Upon all *erect Planes* whether *direct* or *declining*, if it face the *South*, the *South Pole* is elevated; but if it face the *North*, the *North Pole* is elevated, as you may the better perceive by viewing the *erect direct North* and *South Dials* in *Plate 11*.

[3] Upon all *direct East* and *West Planes* (let them recline ever so far) the *North Pole* is elevated; but on their *opposite Incliners* the *South Pole*.

[4] Over all *North reclining Planes*, whether *direct* or *declining*, the *North Pole* is elevated, and over the *opposite Incliners* the *South Pole*.

*Lastly*, Over all *South reclining direct* or *declining*, if the *Plane* pass between the *Zenith* and the *Pole*, the *South Pole* is elevated, as in the *North Pole* on their *opposite Incliners*, and if the *Plane* lie between

\* The *Reclination* of a Plane is the Quantity of *Degrees* which any Plane, on which a Dial is supposed to be drawn, *lies or falls back* from the *truly erect* or *upright Plane*.

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*the Pole and the Horizon, the North Pole is elevated; but the South over their opposite Incliners.*

Now let it be required to make an *East Dial* for *Worcester*, to *recline 40 Degrees*.

According to the *former Method* of reducing it to *new Latitudes*, it will be an *erect Dial* in *Latitude 37 Deg. 47 Min.* (that being the *Complement of the Latitude of Worcester*) *declining from the South Eastward 50 Degrees*, that being the  *Complement of the Plane's Reclinacion*. So that if by the *Directions* in the *XIth Chapter*, you make an *erect Dial* for *37 Deg. 47 Min. North Latitude*, *declining 50 Deg. South East*, it will be an *East Recliner 40 Deg.* from the *Zenith*, in the *Latitude of 52 Deg. 13 Min.* However I shall here shew how to do it *mechanically*.

*First*, You must consider, that the *East and West RECLINERS* have their *Center near the Bottom* of the *Plane*, but the *INCLINERS* of both sorts have their *Centers near the Top*: And the *East INCLINER* and *West RECLINER* must have their *Centers towards the right Hand*; but the *East RECLINER* and *West INCLINER* have their *Centers towards the left Hand*.

These Things being *well understood*, I shall now proceed to practice.

Having made choice of your *Plane*, as suppose *ABCD*. *Plate 8. Fig. 2.*

*For the Substilar Line and Stile's height.*

According to the foregoing *Directions*, I observe that the *Center of this Dial* must be at the *Bottom* towards the *left Hand*: therefore [1] at the *Bottom* of the *Plane*, draw the *Line EF* for the *12 a-clock Line*,

## Ch. XIV. Of East or West Reclining Dials. 47

*Line*, in which make choice of some convenient Place, as at G; [2] chuse G for the *Center* of the *Dial*, and from G draw GH at *right Angles* to EF. [3] Then with one foot of the *Compasses* in G, describe the *Quadrant* IK, and by the help of your *Line of Chords*, set off the *Plane's Reclination* 40 Deg. from I to L, and draw the *Line* GL as long as you can, [4] Also set off from I to M the *Complement of the Latitude of the Place* 37 Deg. 47 Min. and draw the *Line* GM as long as you can: [5] then in any Point at Pleasure in the 12 a-clock *Line* EF, chuse a *Point* as N, and from that *Point* draw a *Line* parallel to GH, as NO; and through the Point where it cuts the *Line* GM, draw PO parallel to EF; [6] take GQ in your *Compasses*, and set it from G to R, and draw RS parallel to the *Meridian* EF, and it will cut NO, in T; [7] set the *Distance* PQ from G to V, and draw VX parallel to TN; [8] take in your *Compasses* GX, and set it from T to Y, and draw GY for the *Substile*; [9] from Y erect the *perpendicular* YW (take VX in your *Compasses*, and set it from Y to W) and draw GW for the *Stile*: The *Triangle* GYW, representing the *Stile* of your *Dial*, which being erected *perpendicular* to the *Plane*, upon the *Substile* GY, shall give the *Hour* by the *Shadow* of its *upper* edge.

### For the Hour Lines.

[1] Chuse a *Point* at Pleasure in the *Substile* GY, as at a; through that, at *right Angles* thereto, draw the *Line* ba, as long as you can; set one foot of the *Compasses* in a, viz. the *Point* where the *Line* ba cuts the *Substile*, and take the *nearest distance* to the *Stile's height*; let one foot rest in a, and turn the other to Æ in the *Substile*, and on Æ as a *Center* describe



## 48 Of East or West Reclining *Dials*. Ch. XIV.

scribe the *Semicircle* (or a whole *Circle* if you please).  
 [2] Lay a Ruler to the *Center* of the *Circle* at  $\text{Æ}$ ,  
 and to  $d$ , that is, where the *Line*  $ba$  cuts the 12 *a-*  
*clock Line*  $GF$ , and where the Ruler cuts the *Circle*,  
 there you are to begin to divide it into 24 *equal* Parts:  
 a Ruler laid to  $\text{Æ}$ , and to the *equal* Parts in the *Cir-*  
*cle*, will cut the *Line*  $ba$  into *unequal* Parts, where  
 make *Marks* \*\*\* Lastly, A Ruler laid to the *Center*  
 of the Dial at  $G$ , and to those *Marks* \*\*\* in the *Line*  
 $ba$ , will be the true *Hour Lines* required.

The *Line*  $GF$  being the 12 *a-clock Line*, you must  
 place 12 at the *end*, as you see in the *Figure*, and the rest  
 11. 10. 9. 8. 7. 6. and then your Dial is finished.

*N. B.* In drawing this Dial, you have made *three*  
*more*; for if it is turned *upside down*, then it is a *West*  
*Dial inclining 40 Degrees*, with this *Alteration only*,  
 that where 11 now stands you must place 1, and 2 where  
 10 is, &c. and consequently the *Substile* will then be as  
 much on the *right Hand*, as it is now on the *left*.

If it were drawn upon *oiled Paper*, the *back-side*  
 would be a *West Dial, reclining 40 Deg. only* the  
 Figures 12. 10. 9. &c. must be 1. 2. 3. &c.

Lastly, If the 12 *a-clock Line*  $GF$  be turned *up-*  
*wards*, the *back-side* will be an *East Dial inclining*  
*40 Deg.* and the Figures must remain just as they are;  
 only the *Substile* must be as far to the *left Hand*  
 of the *perpendicular*  $GH$ , as it is now on the *right*.

n.XIV.

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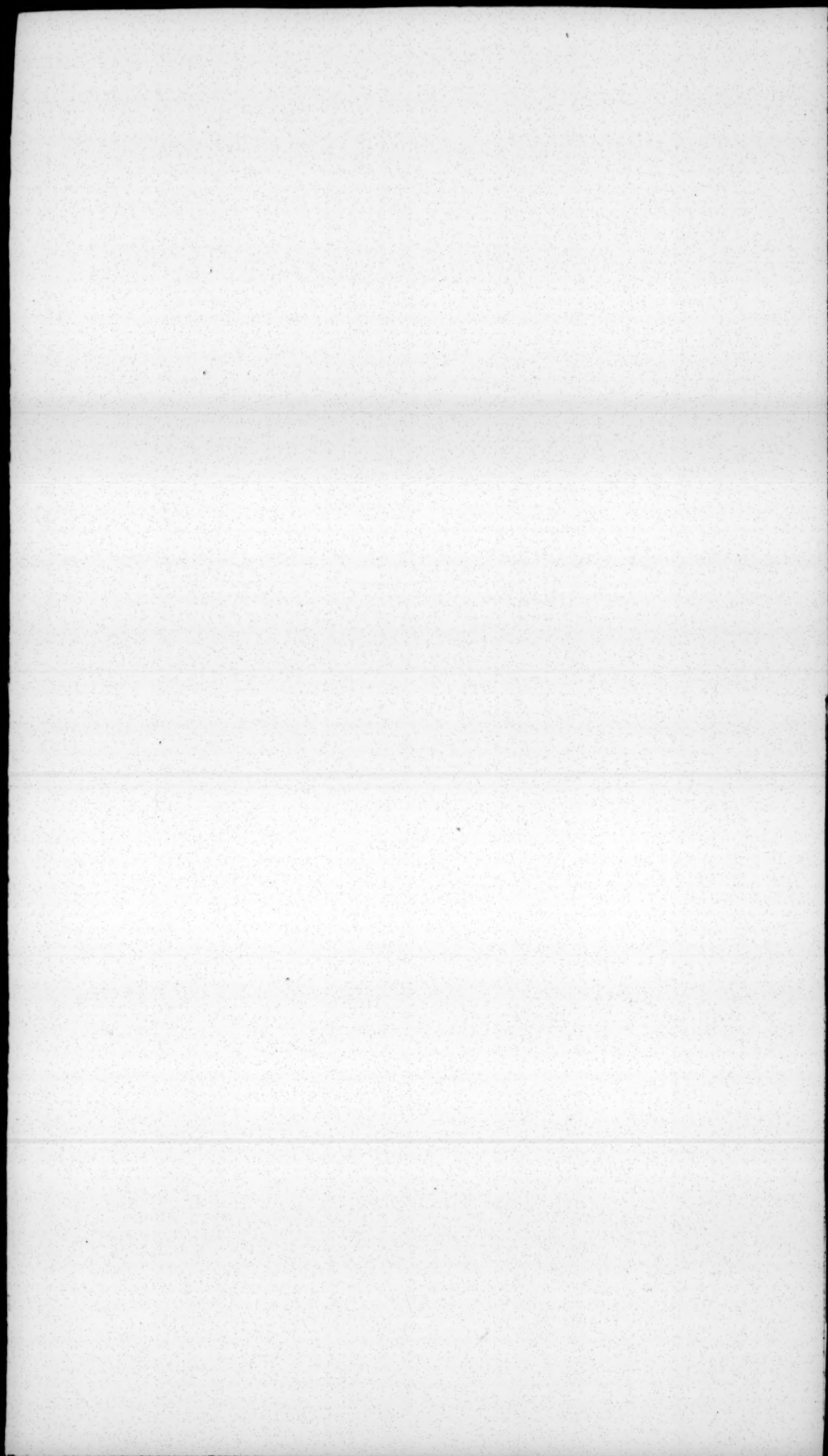
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CHAP.









CHAP. XV. To make a North or South Declining \* Reclining or Inclining Dial.

Plate 9. Fig. 1.

THESE Dial Planes cannot be reduced to new Latitudes without the help of Trigonometry, therefore I shall proceed Mechanically.

Take for an Example a Plane at Edinburgh, declining from the South to the East 30 Deg. and reclining from the Zenith 25 Deg.

First for the Stile.

[1] Draw the Horizontal Line AB; [2] make choice of any convenient Place in the Line AB, as C, for a Center, and draw CD. [3] With your Line of Chords of 60 Deg. draw the Quadrant EF. [4] Take the Complement of the Latitude of Edinburgh 34 Deg. 3 Min. from your Line of Chords, and set it from E to G, and draw the Line CG as long as you can. [5] Take the Plane's Declination 30 Deg. from your Line of Chords, and set it from E to H, and draw the Line CH, as long as you can. [6] Take the Inclination of the Plane 25 Deg. from your Line of Chords, and set it from E to I, and draw the Line CI as long as you can. [7] Make choice of a Point in the Line AB as K, and draw KL parallel to CD, and it cuts the Line CG (the Complement of the Latitude) in M, and thro' that crossing draw MN parallel to AB,

\* Those Dial Planes that lean towards you when you stand before them are called Inclining, and those that lean from you are called Reclining; and Declining, Reclining or Inclining Dials, are those whose Planes neither face directly any of the four Cardinal Points; nor are they either perpendicular or parallel to the Horizon.

E

and



## 50 Of North & South Reclining Dials. Ch. XV.

and it cuts the *Line of Inclination* CI in P. [8] Take CP, and set it from C to Q, draw QV *parallel* to AB. [9] Take RP in your Compasses, and set it from C to S, and draw SH *parallel* to AB, to cut the *Line of Declination* CH in H. [10] Take CK in your Compasses, and set it upon the *Line of Declination* from C to T, and draw ET *parallel* to AB. [11] Take ET in your Compasses, and set it from Q to X, and draw XY *parallel* to CD. [12] Now take in your Compasses the *distance* SH (that is from CD to the *Line of Declination*) and set it from Q to Z, and draw CZ for the *Meridian Line*, or *Hour Line* of 12. [13] Take in your Compasses the *distance* CS, place one Foot in E, and make a Mark where the other Foot falls at *a*. [14] Take Ca, and set it from C to *b* upon the *Line of Inclination*, and draw *bd* *parallel* to CD. [15] Take in your Compasses Cd, carry that extent, and set one Foot of the Compasses in X, and the other will give *e*, draw Ce for the *Substile*, from *e* erect the *Perpendicular* ef. [16] Take *bd*, and set it from *e* to *f*, and draw the Line Cf for the *Stile*, so shall the Triangle Cef be the *Stile* to be erected *Perpendicular* to the Line Ce the *Substile*. The Side Cf, being *parallel* to the *Axis* of the World, and by its *Shadow* is determined the *Hour of the Day*.

### For the Hour Lines.

[1] Chuse a Point in the *Substile* Ce, as *g*, thro' which Point, and at *right Angles* to the *Substile*, draw the Line *gb*. [2] Set one Foot of the Compasses in *g*, and take the *nearest Distance* to the Line Cf, and turn that Foot about to *Æ*; upon *Æ* with the *Distance* *Æg*, draw the *Equinoctial Circle*, or so much of it as will suffice to bring the *Hour Lines* up-  
on

## Ch.XV.Of North & South Reclining Dials. 51

on the Plane that you have occasion for. [3] Lay a Ruler to the *Center* at  $\text{Æ}$ , and to  $i$ , that is, where the Line  $bi$  cuts the *Meridian* or 12 a-clock Line, and there begin to divide the *Equinoctial Circle* into 24 equal Parts; a Ruler laid to  $\text{Æ}$  and to those equal Parts, will divide the Line  $bi$  unequally, and give the Places thro' which the *Hour Lines* must pass: Lastly, Lines drawn from the *Center* of the Dial at  $C$ , thro' those Marks in the Line  $bi$ , shall be the true *Hour Lines* of that Dial; which Number as you see done in the Figure.

Note, You may draw your Dial with Charcoal or Black-lead (that is, the Preparative Work) that it may be taken out when you have put on the Hour Lines, so that nothing may appear but what is really useful.

All other Declining Reclining Dials are made by the same Directions that are given in this above, only by changing the Figures, &c.

As Secondly, The Incliner, Declining from the South Westward, is made by the same Directions, only the Quadrant must be drawn on the other side towards  $A$ , which may be best conceived by supposing this Dial to be drawn on oiled Paper; and looking thro' the Paper, that which on the right side of the Paper was an Inclining Dial, declining from the South Eastward, will be an Inclining Dial, declining from the South Westward.

Thirdly, A North Declining East Recliner is the same with a South Decliner East, Reclining from the Zenith, only the Horizontal Line must be at the Bottom of the Dial; and also the Center of the Quadrant (which is the Center of the Hour Lines) must be above the Line  $AB$ , and towards the left Hand;

and may be represented by a *South Declining East* Recliner, turned *Bottom* upwards, with the *same side* towards you as before.

*Fourthly*, A *North Declining West* Recliner is the same with a *South Declining West* Incliner, only (as before) the *Horizontal Line* A B, must be at the *Bottom* together with the *Center* of the Dial, and the *Quadrant* must be *above the Line*, and towards the *right Hand*, and may be represented by the Dial already described, if imagined to be done upon *oiled Paper*, and seen thro', being turned *Bottom upwards*.

N. B. *The Hours on the North Dials must be numbered the contrary way to those of the South Dials.*

## CHAP. XVI. *To make a Reflective \* Dial.*

Plate 9. Fig. 2.

**T**HIS Dial will shew the true Hour of the Day by *Reflection* on a *Ceiling*, where the *direct* Beams of the Sun can never come, and it will represent the *Sun's Motion*, as truly and regularly *within the House*, as his natural Motion is *without*, provided the *Window* open to the *Southward*, or so that the Sun might shine in or near it.

These sorts of Dials are grounded upon this Principle in *Opticks*, viz. *that the Angle of INCIDENCE is equal to the Angle of REFLECTION: that is*, whatever height the Sun be at any Time, the *same height* has the *reflected Spot* upon the Ceiling.

\* *Reflective* or *reflecting* Dials, are made by a little piece of Looking-Glass duly placed, which reflect the *Sun's Rays* to the top of a Ceiling where the Dial is drawn. N. B. The Piece of Glass should be as thin as it can well be ground,

This



This being understood, it is easy to draw *Hour Lines* upon the *Ceiling* of a Room, or upon any other Place though never so Irregular; and that the *Hour* by the help of a *Piece* of a *Looking-Glass* fixt *Horizontally* in a *Window*, or some other convenient Place for that Purpose, may be truly known.

*To place the Glass.*

[1] Having then made choice of a *Window* towards the *South*, that so you may have as much of the *Morning* and *Afternoon* Sun as possible, take special care to fix your Glass *Horizontal*, otherwise your Work will all be spoiled.

N. B. All *Great Circles*, as *Equinoctial* and *Hour Circles*, are *streight Lines*, and the *lesser Circles*, as *Tropicks* and other *Parallels of the Sun's Declination*, are *\*Conick Sections*: and that *this Dial* (when drawn) is no other than a *Horizontal Dial* for the *same Latitude inverted*, Plate 9. Fig. 2.

*To draw the 12 a-clock Hour Line.*

[2] Having then placed a *Piece* of a *Looking-Glass*, about the *bigness* of a *Sixpence*, marked thus  $\odot$  in the *Figure*. Over *this Glass* hang a *Plumb Line* at 12 a-clock, this String will cast a true *Meridian Line* (i.e. it is the true 12 a-clock *Hour Line*) upon the Floor.

Or if you think that way too difficult, you may find a 12 a-clock *Line* as I have taught in Chap. IV. page 19 and 20. This being done, the 12 a-clock *Line on the Floor*, is to be *transfer'd* to the *Cieling*, which may be performed by the help of *two Plumb Lines*, one held over the Glass  $\odot$ , and the other held over

\* A *Cone* doth somewhat resemble a *Sugar Loaf*, and being cut any where *slope-wise* is called a *Conick Section*.

the other end of the 12 a-clock Line at A, at the other end of the Room; by this means you will have two points on the Cieling, just over your 12 a-clock Line on the Floor, to which two Points on the Cieling stretch a Line blacked with Lamb-black and Oil, and holding it fast at both Ends, (as two Sawyers or Carpenters generally do a CHALKED LINE) strike the black 12 a-clock Line on the Cieling, represented by AC.

*To draw the Equinoctial.*

[3] Make the Angle  $B \odot P$ , equal to the Complement of the Latitude of the Place, as suppose at Ormskirk 36 Deg. 30 Min. which you must do by a String, held one end to the Glass  $\odot$ , and the other to the Cieling represented by  $B \odot$ , and applying the Edge of your Quadrant, till you find the String and Plumbet, cut the Limb at 36 Deg. 30 Min. thro' that Point of the 12 a-clock Line; at B the Equinoctial Circle must pass, which draw at right Angles to the 12 a-clock Line AD, and it is a streight Line as you see in the Figure.

*To draw the Tropick of Cancer.*

[4] Then, because the Sun's greatest height at 12 at Noon, at Ormskirk is 59 Deg. 59 Min. make the Angle  $D \odot P$  equal thereto by help of your Quadrant and String as before: so is the Point D, the Point in the 12 a-clock Line, where the Tropick of Cancer must pass, which, because it is a lesser Circle of the Sphere, it is not a streight Line but a Curve, which must be drawn by help of Table VI; (that is, by having the Sun's height at every Hour the 21st of June for the Latitude of your Place;) so with an even hand, you may draw the Tropick of Cancer GDH.

To

*To draw the Tropic of Capricorn.*

[5] Because the Sun's *least height at 12 at Noon* at Ormskirk is 13 Deg. 1 Min. make the *Angle A ⊙ P* equal thereto, by help of your *Quadrant and String*, so shall A be the *Point* in the 12 a-clock Hour Line on the *Cieling*, where the *Tropick of Capricorn* must pass, and must be drawn by the *Table of the Sun's Altitude at every Hour*, upon the 21st of *December* as above directed, so that ⊙ D represents the *reflected Ray* on the *longest Day*; ⊙ B, when he is in the *Equinoctial*, that is *twice a Year*, viz. on *March 22d*, and *September 21st*, and ⊙ A represents the *reflected Ray* on the *shortest Day*.

*To draw the Hour Lines.*

[6] With any convenient opening of your *Compasses*, draw the *Semicircle* ⊙ LM, and divide it into 12 equal Parts, because 15 Deg. in the *Equinoctial* is equal to one Hour in Time, as by Table III.

Hence, because the *Center* of the *Dial* doth not fall in the room, but out of it in the open Air at O, for which Reason (before the *Hour Lines* can be drawn) you must find the *Angle* that each *Hour Line* makes with the 12 a-clock Hour Line, their *Complements* are what they make with the *Equinoctial*; this is easily done by *Calculation*, but because I have throughout this Treatise laid that Method aside, and kept strictly to a *Mechanick Method*, your best Way will now be to draw an *Horizontal Dial* for the *Latitude* of Ormskirk, which is 53 Deg. 30 Min. as has been taught in Chap. IV. and with your *Compasses* and *Line of Chords* measure the *Angles* that the *Hour Lines* make with the *Meridian*, and set them down as followeth.



| Hours. |    | Angles<br>with the<br>Meridian. | Angles<br>with the<br>Equinoct. |    |    |
|--------|----|---------------------------------|---------------------------------|----|----|
| 12     |    | 0                               | 0                               | 0  | 0  |
| 1      | 11 | 12                              | 10                              | 77 | 50 |
| 2      | 10 | 24                              | 54                              | 65 | 6  |
| 3      | 9  | 38                              | 47                              | 51 | 13 |
| 4      | 8  | 54                              | 19                              | 35 | 41 |
| 5      | 7  | 71                              | 34                              | 18 | 26 |
| 6      |    | 90                              | 00                              | 00 | 00 |

Then with your *Quadrant* lay it to the 12 *a-clock* Hour Line, and make *Angles* there upon the *Cieling* equal to those in the *second Column*; or else you may lay it to the *Equinoctial* Line on the *Cieling*, and make the *Angles* of every Hour equal to those in the *third Column* of this *Table*, and by the help of your *blackened String*, as before directed, draw the *Hour Lines* upon the *Cieling*, which shall be the *true Hour Lines* required.

#### Another Way to draw the Hour Lines.

Or if you think this way *too tedious*, when you have your *Horizontal Dial* fitted to your *Latitude*, place the *Center* of your *Horizontal Dial* in the *Center* of the *Glass*, and fix a *Thread* in the *Center* of the *Dial*; lay the *Thread* streight over every *Hour* of your *Horizontal Dial*, fasten it at the *other side* of the *Room*; and so transfer them to the *Cieling*, as was shewn in drawing the 12 *a-clock* Line from the *Floor* by help of the *Plumb Lines*; thus have I given you *two* Methods by which you may draw the *Hour Lines* on the *Cieling*, which I leave to the *judicious Practitioner* to make use of which he pleases.

#### How to make a Table for drawing of the Hour Lines.

The framing of a *Table* of the *Angles* that the *Hour Lines* make with the 12 *a-clock* Hour Line and *Equinoctial*, is made after this manner, *viz.* Suppose I would measure the Angle *DOP* in Plate 9. Fig. 2. Take your *Compasses* and extend on the *Line of Chords* from the end of the Line at *O* to 60.

Degs.

*Deg.* with *that extent* set *one foot* in  $\odot$ , and draw the *Arch* PD; take the said *Arch* PD in your *Compasses*, and apply it to your *Line of Chords*, and you will find it to contain *59 Deg. 59 Min.* and such is the *Angle* D $\odot$ P. And after the same manner is *any other Angle* measured.

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CHAP. XVII. To make a Refracted\* *Dial*.

FOR this purpose you must have in readiness an *Horizontal Dial* for the *Latitude of your Place*, and then stick up a *Pin*, or *Wire*, or assign any *Point* in any *hollow Bowl*, or *Dish*, to shew the *Hour*, and make that the *Center* of your *Horizontal Dial*; then fix upon any *Place* on the *Edges* of the *Bowl*, or *Dish*, for the *12 a-clock Hour Line*, and transfer the rest of the *Hour Lines* from the *Horizontal Dial* to the *Edge* of the *Bowl*; and taking away the *Horizontal Dial*, hold up a *String* from the *End* of the said *Pin* fastened thereto, over the *12 a-clock Hour Line* equal to the *Latitude* of your *Habitation*; and this is done by applying the *Edge* of your *Quadrant* to the *String*, till it cuts the *Latitude of the Place* upon the *Limb* thereof.

Then with a *Candle*, by bringing the *Thread* to cast a *Shadow* on any *Hour Point*, just before marked upon the *Edge* of the *Bowl*, that *Shade* in the *Bowl* is the *Place* to which the *true Hour Line* must be drawn; and if the *Bowl* be full of *Water*, or any other *Liquor*, when the *Hour Lines* are drawn, it

\* *Refracted Dials* are such as shew the *true Hour* only by means of some *refracting transparent Fluid*, such as *Water*, &c.

will never shew the *true Hour* by the Shadow of the Top of the Pin, but when the Bowl is filled again with the same Liquor.

For more particular Satisfaction, see my *Astronomy* under the Word *Refraction*, Vol. I. Page 38.

## CH A P. XVIII. To make a Globe Dial.

Plate 10. Fig. 1.

**T**HIS Dial is drawn upon a *solid Ball* or *Globe*, and shews the *Hour* of the Day without a *Stile* or *Gnomon*.

The manner of *turning* round Balls, is well known to Workmen; but if a large *Stone Ball* is to be made, that cannot be turned because of its *Weight*.

You must therefore in the first Place form it *globular* with a *Chissel*, and then take a wooden or brass *Semicircle* (as in Fig. 2.) of the *same Diameter*, as you design *your Ball* (the bigger the better;) this being done, turn the *Semicircle* about the Ball, and take away all the *Superfluities* with a *Rasp*, until the *Semicircle* every where, and every way, just touches the *Superficies* thereof; afterwards make it smooth with a *Pumice Stone*, or *Sea Dog's Fish Skin*.

### For the Circles of the Sphere.

The *Globe* being thus finished, and set in your Garden upon a *Pedestal*, as Figure 1, proceed to draw thereon the *Circles of the Sphere* (by help of a Pair of *spheric Compasses*, or a *Semicircle* that just fits the *Globe*) as AB the *Horizon*, ZN the *prime Vertical*, so shall Z be your *Zenith*, and N your *Nadir*.

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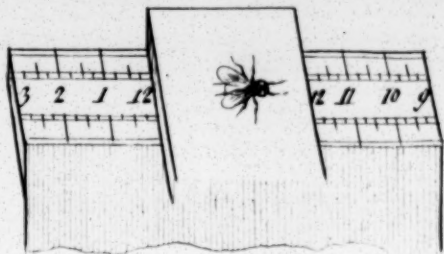
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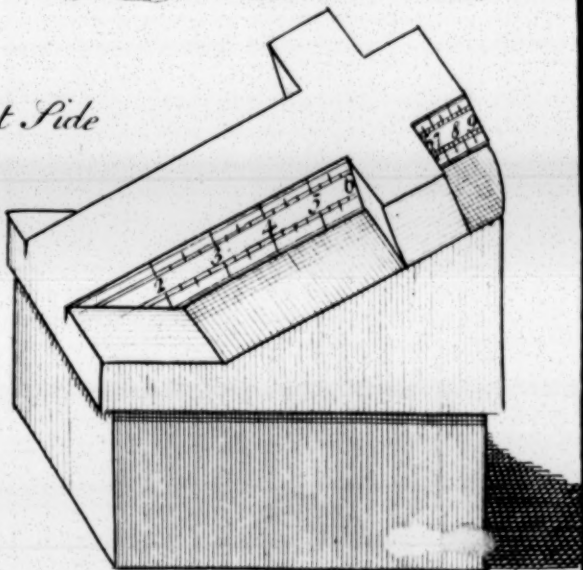
*The Cross Dial view'd in three different positions*

*South End*

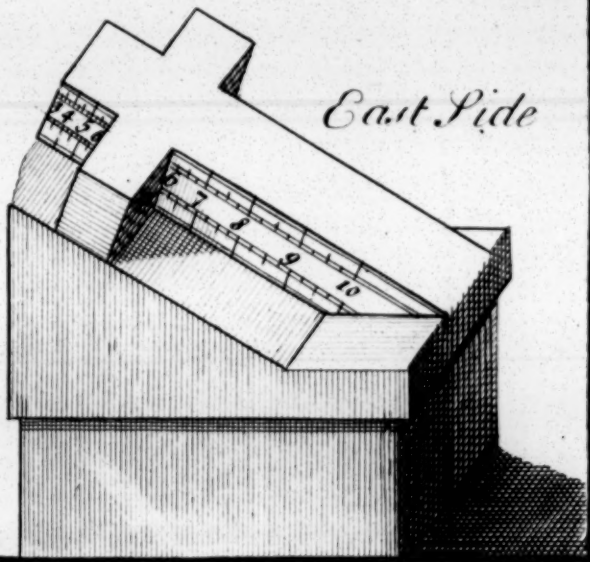
*Plate X*



*West Side*



*East Side*



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Plate 10

Fig. I.

A Globe Dial

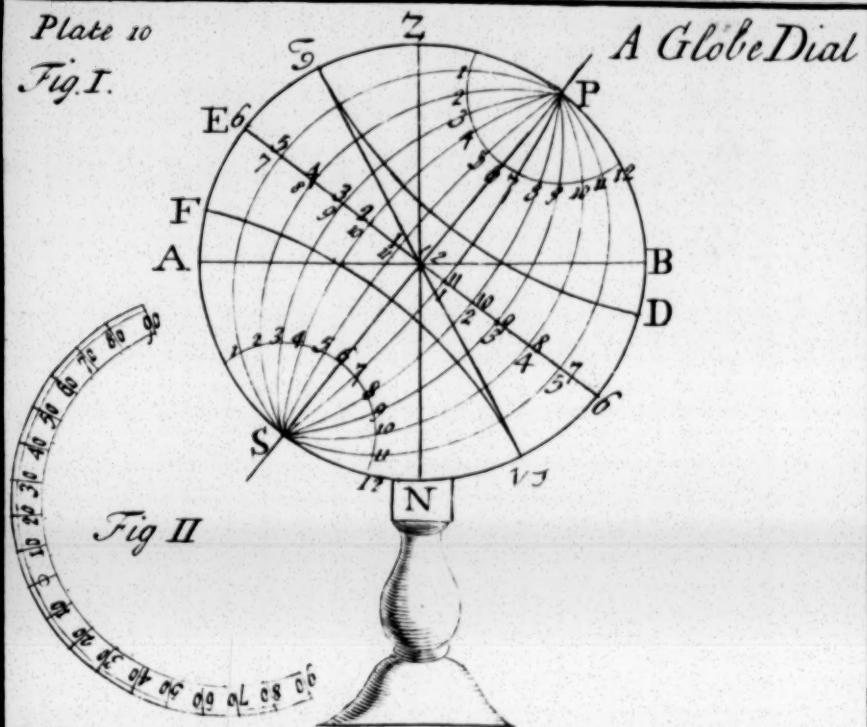
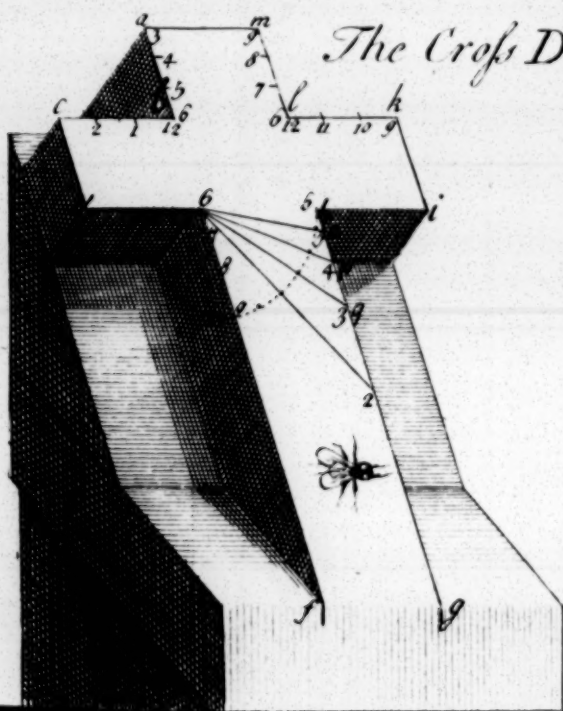
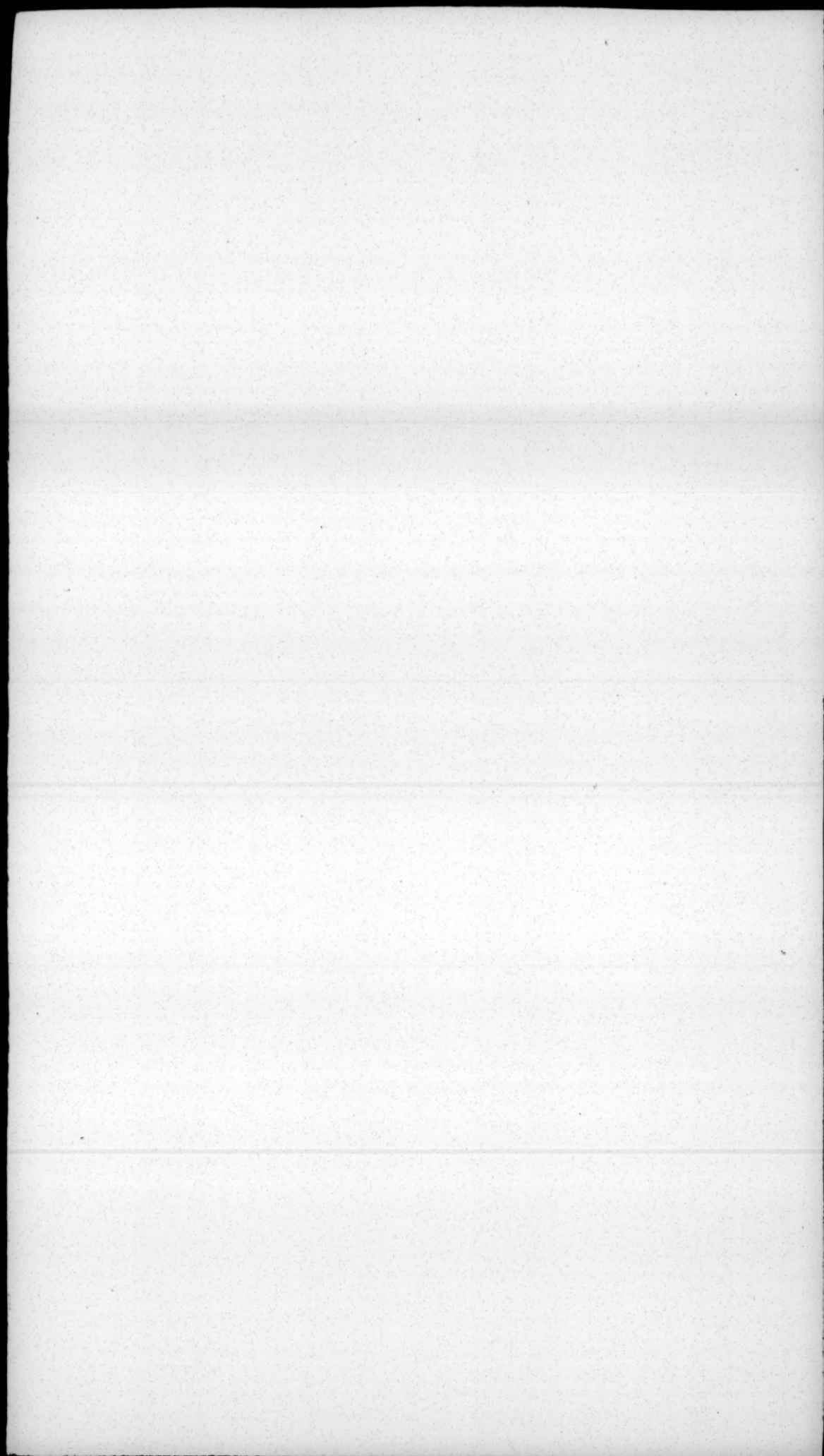


Fig III

The Cross Dial







Draw PS for the *Earth's Axis* to any *Latitude*, as suppose that of *Dublin* 53 Deg. 16 Min. so shall P be the *North Pole*, and S the *South Pole* of the *World*. Make ZÆ equal to BP, and draw Ææ for the *Equinoctial*, which divide into 24 equal Parts, and draw the *Hour Circles* or *Meridians* all meeting in the *Poles* of the *World*.

Your *Semicircle* being divided into 180 Deg. and numbered as you see in Fig. 2. mark 23 Deg. 29 Min. from the *Equinoctial* at Æ to ☿ and F, and draw ☿D for the *Tropic of Cancer*; and Fvs for the *Tropic of Capricorn*; also from the *Poles* at P and S mark (by help of your *Semicircle*) 23 Deg. 29 Min. and draw the two *Polar Circles*; 12, 12. Lastly, Draw ☿vs for the *Ecliptic*, and thereon place the 12 *Signs of the Zodiac*, beginning at the *Equinoctial*, where the *Ecliptic* cuts it with ♈; at 30 Degrees further, place ♊, at 30 Degrees from that, put ♉, at 30 Degrees more, put ♋, which will be where the *Ecliptic* cuts the *Tropic of Cancer*, and so on, at every 30 Degrees in the *Ecliptic*, place the *Signs* in order thus, ♈ ♉ ♊ ♋ ♌ ♍ ♎ ♏ ♐ ♑ ♒ ♓. I have omitted them in the Figure to avoid Confusion.

*For the placing of the Hours.*

The *Hours* must be numbered in the *Equinoctial*, placing 12 at the *East* and *West Points* of the *Horizon*, and 6 upon the *Meridian*. Then because one half of the *Globe* (nearly) is illuminated when the *Sun* shines, and the other half remains in *Darkness*, and so the *Extremity* of the *Light* shews the *Hour* in two opposite Places.

If moreover the *different Countries* on the *Earth's Superficies*, as likewise the *principal Cities* were laid down upon the *Globe*, according to their true *Latitudes*

*tudes* and *Longitudes*, you may discover any Moment the Sun shines upon the same, by the *illuminated Part* thereof, what Places on the Earth are *enlightened*, and what Places are in *Darkness*. The *Extremity of the Shadow* shews likewise what Places the Sun is *Rising* or *Setting* at; and what Places have *long Days*; these with many more *curious Problems* are seen at one View, too many to be enumerated in this Place.

*This Dial* is the *most natural* of all others, because it resembles *the Earth itself*, and the *exact manner of the Sun's shining* thereon.

*Note*, You may draw as many *Parallels of Declination* upon it as you please, by the *Table* of the *Sun's Declination*. See Table I.

Also if two *Wires* be put in, one at P and another at S, and 12 at the *Meridian*, and the *Hours numbered* as you see, that *Wire* at P, will give the *Hour* in the *Summer*, and that at S the *Hour* in the *Winter*.

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## CHAP. XIX. To make a Cross Dial, a Star Dial, and a Window Dial.

Plate 10. Fig. 3.

**A** *Cross Dial* is that which shews the *true Hour* of the Day, without a *Stile*, by the *Shadow of one Part* of the Dial itself, appearing upon *another Part* thereof.

There is one of *this* sort of Dials near the *South-West Corner of Middle Moorfields, London*.\*

For

\* The *Inscription* upon this Dial being cut in *Iron*, and exposed to the Weather, it is so defaced, that it required much Pains and Art to render it legible, and therefore I desire the Reader's Excuse for preserving

*For the making of this Sort of Dial.*

You need have no regard to the *Latitude of the Place*, for that is to be considered in the *placing*, and not in the *making* of it.

[1] In order to which, prepare a Piece of *Wood* or *Stone* of what Size you please, and shape it in the *Form* of a *Cross*, so that *ab, bc, cd, de, eh, hi, ik, kl, lm*, and *ma* may be *all equal*: *ef*, may be *more than double* to *ae*: that in *London* is 25 Inches, and 5 Tenths of an Inch long from *a* to *f*, and *am* is 4 Inches and 8 Tenths, *ef* 15 Inches and 8 Tenths, and the *Depth* or *Thickness* is 6 Inches, 8 Tenths. This premised:

[2] Set one Foot of your Compasses in *e*, and draw the *Arch* or *Quadrant* *bn*, which divide into six equal Parts, for six Hours, because it is a *Quarter of a Circle*; lay a Ruler from the Center *e*, and draw *eo, ep, eq*.

[3] Now the *Position* of this Dial being such that its End *am*, must face the *South*, and the upper Part of it to lie parallel with the *Equinoctial*, the Sun at 12 a-clock will shine just along the Line *ab* and *ml*. Therefore you must place 12 at *b* and *l*, then it is plain that from 12 to 3 the Shadow of the Corner *a* will pass along the Line *bc*; therefore take from the Quadrant just now drawn *bn* the Distance *bo*, and set it from 12 to 1.

[4] Take also *bp*, and set from 12 to 2, *bq* being equal to *bc*, at *c* place 3, where the Shadow of the Corner *a* goes quite off the Dial at *c*, or 3 in the Afternoon; but then the Shadow of the Corner *i*,

serving it. "This Dial was placed here as a Boundary of the Parish of St. Stephens, Coleman-Street, in the memorable Year 1706, and in the fifth Year of the glorious Reign of our most gracious Sovereign Queen ANNE. whom GOD long preserve. Robert Trevitt, Painter, Fecit."

will



will come on the Side *hg* at *q*, or 3 a-clock, where place the Figure 3; at *p* 4, at *o* 5, and at *b* 6 in the very Corner: because at 6 the Sun will shine right along the Line *ib*; place 6 also at the Corner *l*, because the Sun at 6 shines right along the Line *lk*, and from 6 till 9 (if it be in a Latitude where the Sun continues up so late at Night) the Shadow of the Corner at *k* is passing along the Line *lm*.

[5] Therefore take in your Compasses the Distance *bo*, and set from 6 to 7.

[6] Take *bp*, and set from 6 to 8 along the Line *lm*; and the Distance *bq* is equal to *lm*; therefore at the Corner *m*, place 9, because the Shadow of the Corner *k*, goes off the Line *lm* at 9.

[7] Then for the Morning Hours the Shadow of the Point *c* will enter upon the Line *ab* at the Point *a*, just at 3 in the Morning; therefore draw Lines from 7 and 8 in the Line *lm*, which let be drawn parallel to *am*, and having placed 3 at the Corner *a*, place 4 right against 8, 5 against 7, so will 6 be in the Corner *b*, because at 6 the Sun shines just along the Line *cb*, and from 6 till 9 the Shadow of the Point *d* is passing along the Side *ef*.

[8] Therefore having placed 6 in the Corner *e*, draw Lines from the Points *opq*, parallel to *di*, and at those Points put the Figures 7, 8, 9, for when the Shadow of the Point *d* comes to 9, the Shadow of the Point *m* is at the Point *k*, and from 9 to 12 the Shadow of *m* passeth along the Line *kl*, and at 12 the Shadow of *m*, is come to *l*.

[9] Therefore take the Distances *bo*, *bp*, *bq*, and set them from *l*, to 11 and 10, the Distance *bq* being just equal to *lk*, and thus is the Dial finished.

The Sun as it goes off from one Part of it comes on to another Part thereof; so that the Time of the Day

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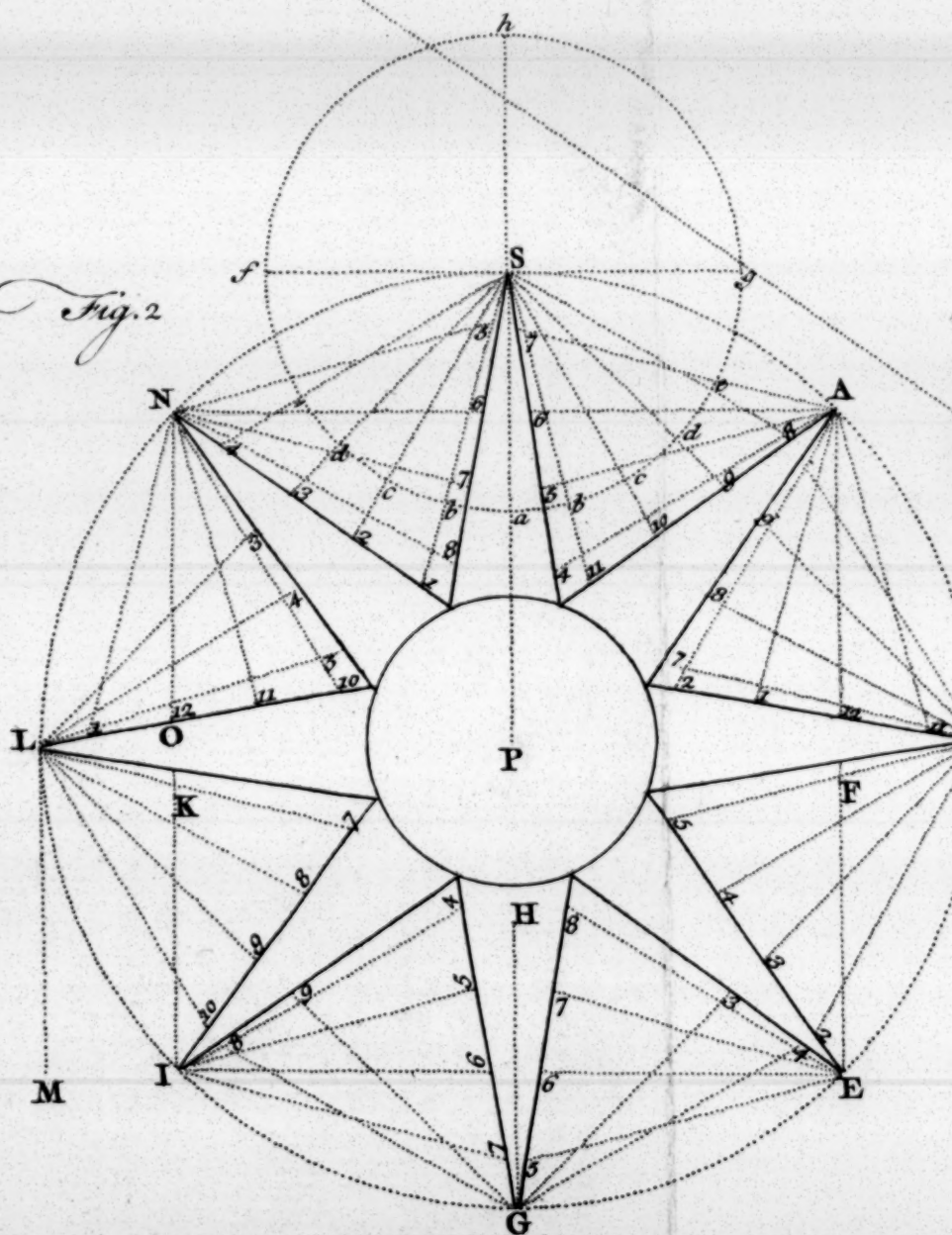
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Figure 3. Is a Horizontal Dial, & shews the position  
Hour Lines, according as the Dial Plain is either  
Circle, &c. —

Fig. 2





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in is either a Square?

Fig. 3

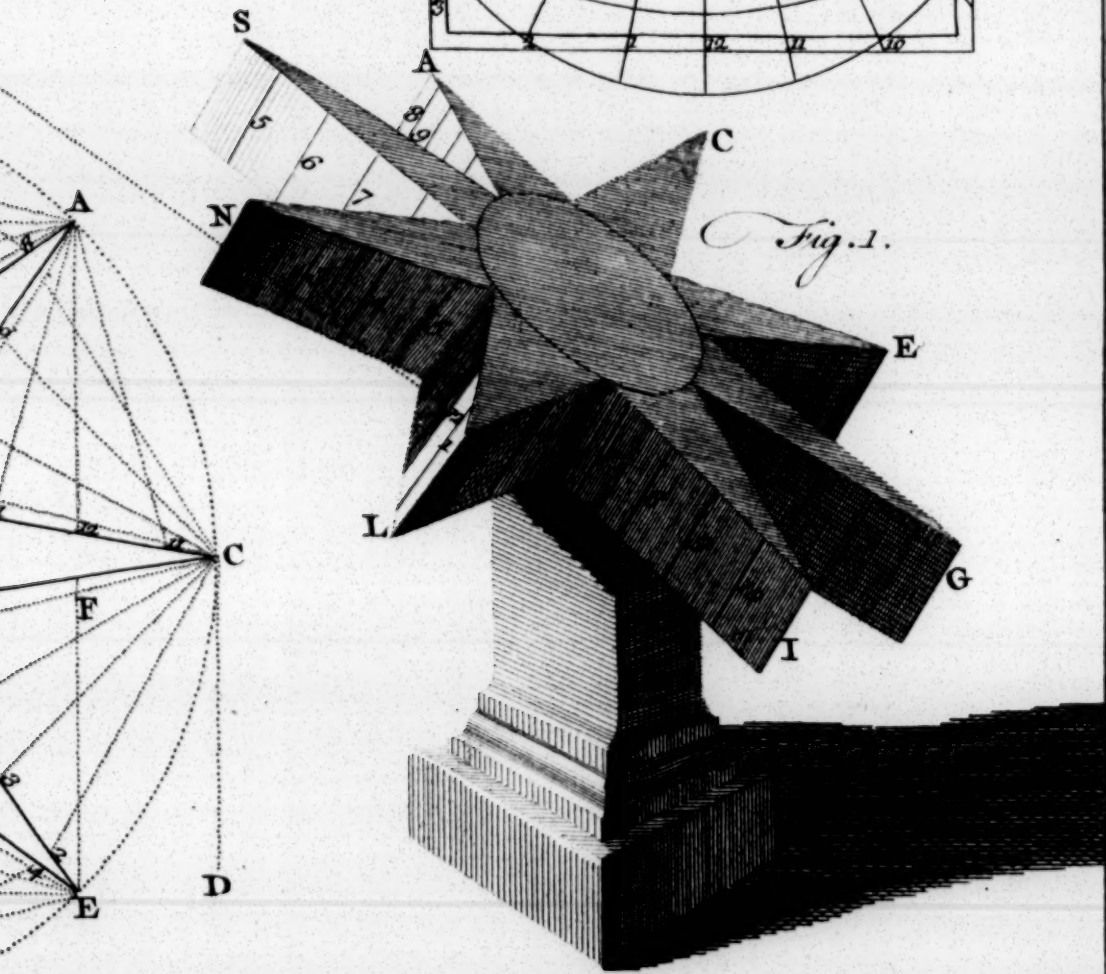
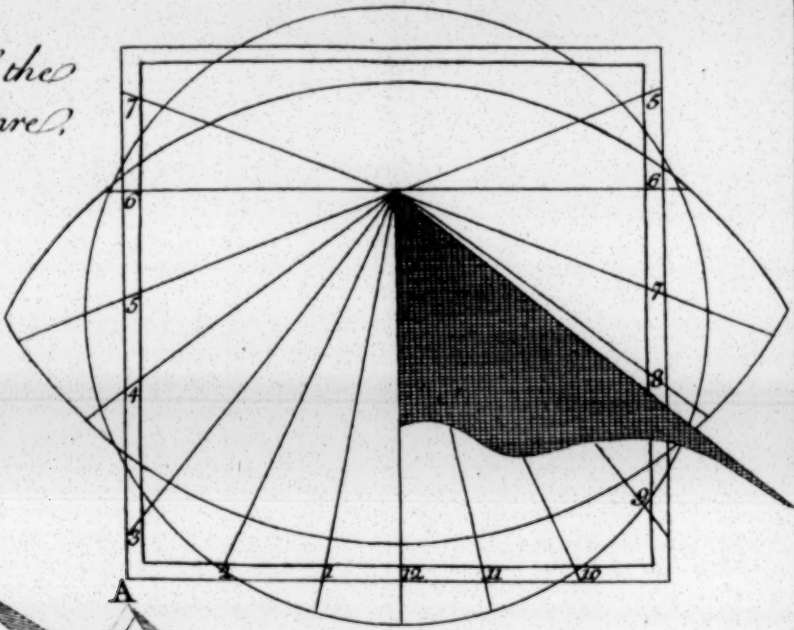


Fig. 1.

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Day may *always* be found upon *some Part* or *other* of it, when the Sun shineth.

The Reason why these Dials require *Thickness*, as well as other *Dimensions*, is, because being placed *parallel to the Equinoctial*, the Sun shines upon the *upper Face* all the *Summer*, and on the *longest Day* is *elevated 23 Deg. 29 Min. above* the Plane of the Dial, and *consequently* the *Shadow* of *a* will fall at *Noon* in the *Line ab*, and not in the *Point b*, but at an *Angle of 23 Deg. 29 Min.* therewith, (that being the Sun's greatest Declination on the longest Day.) And on the *shortest Day* the *Shadow* of *a*, will be *below* the Plane or *Line ab*, and make an *Angle* of *23 Deg. 29 Min.*

This Dial is *universal*, for when you have made one, according to the above Directions, there is nothing to do but to fix it in your Garden, &c. by help of your *Quadrant*, to the *Elevation of the Equinoctial*, or *Complement of the Latitude of your Habitation*, and so that the Side *ab* may *exactly* face the *South*.

If you would place this Dial in any Place *within the Polar Circles*, you must then make all the *Ends* of an *equal length*, viz. *ef*, &c. *equal to ab*; otherwise, the *Shadow* would quit one Side before it comes on another, as you may the better perceive by viewing the Figure in Plate X. Fig. 3.

### Of the STAR DIAL.

#### Plate X B.

This is an *Equinoctial Dial*, made in the *Form* of a *Star*, having eight *Rays* or *Points*, but *no Stile*, the *Thickness* of the *Ends* of the *Rays* (being perpendicular



pendicular to the Surface of the Dial) performing the Office of the *Stile* in a common *Equinoctial Dial*, by casting their *Shadows* on the *Sides* of the *Rays* or *Points*.

The only Dial we have seen of this kind is of the following Dimensions. The *Radius* of the outer *imaginary Circle* PS (Plate X B. Fig. 2.) is 7 Inches, and that of the inner Circle P  $\alpha$ , 2 Inches and 1 quarter; and the *Thickness* of it 2 Inches and a half. But in order to assist the Reader's Imagination in forming a true Idea of this Dial, we have given a *perspective View* of it on Plate X B Fig. 1. in which the *Hour Lines* on the Rays S N L I G are distinctly seen; and the same is to be understood of the other Rays, whose Sides cannot be seen in this View. *Note*, the same Rays in both figures are marked with the same Letters.

The *Construction* of this Dial is the same with that of the *Equinoctial Dial*, explained in Chap III. Page 15. The *only Difference* being, that instead of *one Stile*, which is there placed in the Center of the Dial, the *End of each Ray performs the Office of a Stile*, and therefore the *whole* is properly a *Composition of eight Dials*; some of these Stiles shew *one Hour*, and some *another*. Thus the *Stile*, or *End of the Ray S*, will, in the Morning, cast its Shadow on the *Side of the Ray A*, and there shew the Hours 8, 9, 10, 11; at *Noon* it will cast *no Shadow*; but in the *Afternoon* its Shadow will be projected on the *Side of N*, and shew the Hours 1, 2, 3, 4. The *Stile*, or End of the Ray A, will, by casting its Shadow against the *side of C*, shew the Hours 11, 12, 1, 2. At *three* it will cast *no shadow*; but afterwards its Shadow will be projected on the *side of S*, and there shew the Hours 4, 5, 6, 7. The same is to be understood

derstood of the *rest of the Rays*, and is sufficiently plain from the Figure. For as the *eight Rays* are at *equal Distances* from each other, they face the *Eight principal Points of the Compass*. That is, the Ray S faces the *South*, A the *South-West*, C the *West*, E the *North-West*, G the *North*, I the *North-East*, L the *East*, and N the *South-East*. And as the Sun is, with regard to the *Equinoctial*, directly *South* at *Noon*, *South-West* at three, *West* at six, *North-West* at nine, *North* at *midnight*, *North-East* at three in the *Morning*, *East* at six, and *South-East* at nine; therefore the Rays respecting those Points, will then cast no Shadow. That is, the Ray L at *six in the Morning* will cast no Shadow, *both Sides* of the Ray being at that Time equally illuminated. The same is to be understood of all the rest.

In order to *construct* this Dial, divide the outer Circle S, C, G, L, (Plate X. B. Fig. 2.) into *eight equal parts*, and having described a small concentric Circle P x H, draw the *eight Rays* S, A, C, E, G, I, L, N, as you see in the figure. Then make choice of one of the Rays to face the *South*, which in the Figure is that marked S. On S, the Point of this Ray, with the *Radius* of your Line of Chords, describe a Circle, as *a g b f*; then will S a be the *meridian Line*. From a let off 15 Degrees both ways towards b, and also from b to c, from c to d, and from d to e. From S, through b, c, d, e, draw Lines both ways, till they cut the *Sides of the next Rays* A and N, which will give the *Hour Lines*. Those on A, because to the Westward of the Meridian Line, will be 8, 9, 10, 11, and those on N, being to the Eastward of it, 1, 2, 3, 4. The very same Method must be pursued with regard to the rest of the Rays; observing that all their *Meridian Lines* must be *parallel to the first, S a*.

Thus A B is the *Meridian Line* of A, C D of C, E F of E, G H of G, I K of I, L M of L, and N O of N. Having thus found the Places of all the *Hour Lines* on the *Projection*, transfer them to the *correspondent Rays* of the *real Dial*, and draw *Lines perpendicular to the Surface*, or *parallel to the Ends of the Rays*, which will be the *Hour Lines* required, as you see in the *Perspective View* of the Dial on Plate X.B. Fig. 1.

Having thus *transfer'd* the *Hour Lines* from the *Projection* to your *Dial*, nothing remains but to fix it in a *true Position*. That is, to fix it so, that its *Surface be parallel to the Equinoctial*, and the Ray S point directly to the South, or to the Sun when he is in the *Meridian*. This Position is the same with that of the *Equinoctial Dial*, described in Chap. III. Page 15, where the Reader will find sufficient Instructions for this Purpose.

Thus having in the foregoing Work shewn how to make all manner of useful Dials, I think it only remains now to shew how

### *To make a WINDOW Dial.*

By this Dial, you may know the Hour of the Day tho' the Sun doth not shine out bright, but appears ever so little thro' the Clouds: And so you may in the Night by the Stars, and Moon.

If your Window face any Point of the *Compass* (near the South is best) then find its *Declination*, as has been taught in Chap. X. then procure a large Sheet of thick writing Paper, and thereon make the Draught of your Dial (as taught in Chap. XI.) which done, either with Wax or a few small Nails, fasten your *Paper Draught* to the Plane (which I suppose to be made ready for that Purpose) upon which you design to draw the Dial. Having placed the Center of your *Paper Dial* in the very Place where you design to



to fix the *Stile* in the Plane, there fasten a String, and with this *String* (or a *Ruler*) transfer the *Hours* and *Quarters* from your *Paper Draught* upon the *Window*. And this you will find to be a very easy, expeditious, and exact Way of drawing the *Hour Lines* and *Quarters* upon any Plane whatsoever. Then get an *Iron Rod* about the *Thick-ness* of your *Hour Lines*, and nail it to the *Window Frame* exactly in that *Place* where the *Center* of your *Paper Draught* was placed, and set it to the *Latitude* of your *Place* by help of your *Quadrant*, which is done by putting that *Edge* of it to the *Stile* wherein the *Sights* are, and raising the *Stile* higher or lower till the *Thread* cuts the *Limb* in the *Degree* of the *Latitude* of your *Place*; and there fasten it at *right Angles* over the *Substile Line*.

You may put *Figures* (or any *Marks* for your own *Information*) to the *Hour Lines*, and thus is your *Dial* finished: and, how pleasant this will be, to sit in your *House*, &c. to see the *Time* of the *Day* that the *Sun* shines upon the *Window*, will best appear from the *Dial* when thus made: since at any *Time* when you can see the *Sun* just thro' the *Clouds*, you may then tell the *Hour* of the *Day* as well as if it shone ever so bright; for look thro' the *Window*, and take the *Stile* between your *Eye* and the *Sun*, and at the same *Time* you'll see the *Hour* where the *Stile's* shade will fall upon the *Window*, and that is the true *Hour* of the *Day*. Also, in the *Night* you may do the same by any *known Star*, by first knowing the *Time* the *Star* will be upon the *Meridian* or *South*, and as much as it wants of the *South* by the *Dial* subtracted from the *Time* of *Southing*, gives the true *Hour* of the *Night*, but if it be past the *South* by the *Dial*, add so much to the *Time* of *Southing*, and you have the *Time* of the *Night*. The same Method is to be used for the *Time* of the *Night* by the *Moon*.

This Method of transferring the *Hour Lines* from your proper draught, is what you may use in making of any *Dial*, which I recommend as being most practicable.

## TABLE I.

A TABLE of the *Sun's Declination* exactly calculated for the Year 1754, which (for the Use of Dialling) will serve for this Age without any sensible Error.

|    | <i>Jan.</i> |      | <i>Feb.</i> |      | <i>Mar.</i> |      | <i>April</i> |      | <i>May</i> |      | <i>June</i> |      |
|----|-------------|------|-------------|------|-------------|------|--------------|------|------------|------|-------------|------|
|    | D.          | M.   | D.          | M.   | D.          | M.   | D.           | M.   | D.         | M.   | D.          | M.   |
| 1  | 23          | S 00 | 17          | S 02 | 7           | S 30 | 4            | N 37 | 15         | N 08 | 22          | N 05 |
| 2  | 22          | 55   | 16          | 45   | 7           | 07   | 5            | 00   | 15         | 26   | 22          | 13   |
| 3  | 22          | 49   | 16          | 27   | 6           | 44   | 5            | 23   | 15         | 43   | 22          | 21   |
| 4  | 22          | 43   | 16          | 09   | 6           | 21   | 5            | 46   | 16         | 01   | 22          | 28   |
| 5  | 22          | 36   | 15          | 51   | 5           | 58   | 6            | 09   | 16         | 18   | 22          | 35   |
| 6  | 22          | 29   | 15          | 32   | 5           | 34   | 6            | 31   | 16         | 35   | 22          | 41   |
| 7  | 22          | 22   | 15          | 14   | 5           | 11   | 6            | 54   | 16         | 52   | 22          | 47   |
| 8  | 22          | 14   | 14          | 55   | 4           | 48   | 7            | 16   | 17         | 08   | 22          | 53   |
| 9  | 22          | 05   | 14          | 36   | 4           | 24   | 7            | 39   | 17         | 24   | 22          | 58   |
| 10 | 21          | 56   | 14          | 16   | 4           | 01   | 8            | 01   | 17         | 40   | 23          | 01   |
| 11 | 21          | 47   | 13          | 56   | 3           | 37   | 8            | 23   | 17         | 56   | 23          | 07   |
| 12 | 21          | 37   | 13          | 36   | 3           | 14   | 8            | 45   | 18         | 11   | 23          | 11   |
| 13 | 21          | 27   | 13          | 16   | 2           | 50   | 9            | 07   | 18         | 26   | 23          | 15   |
| 14 | 21          | 16   | 12          | 56   | 2           | 27   | 9            | 28   | 18         | 40   | 23          | 18   |
| 15 | 21          | 05   | 12          | 35   | 2           | 03   | 9            | 50   | 18         | 55   | 23          | 21   |
| 16 | 20          | 54   | 12          | 15   | 1           | 39   | 10           | 11   | 19         | 09   | 23          | 23   |
| 17 | 20          | 42   | 11          | 54   | 1           | 15   | 10           | 32   | 19         | 22   | 23          | 25   |
| 18 | 20          | 30   | 11          | 33   | 0           | 52   | 10           | 53   | 19         | 36   | 23          | 26   |
| 19 | 20          | 18   | 11          | 11   | 0           | 28   | 11           | 14   | 19         | 48   | 23          | 27   |
| 20 | 20          | 05   | 10          | 50   | 0           | 04   | 11           | 35   | 20         | 01   | 23          | 28   |
| 21 | 19          | 51   | 10          | 28   | 0           | N 19 | 11           | 55   | 20         | 13   | 23          | 29   |
| 22 | 19          | 38   | 10          | 06   | 0           | 43   | 12           | 15   | 20         | 25   | 23          | 29   |
| 23 | 19          | 24   | 9           | 44   | 1           | 07   | 12           | 35   | 20         | 37   | 23          | 28   |
| 24 | 19          | 09   | 9           | 22   | 1           | 30   | 12           | 55   | 20         | 48   | 23          | 27   |
| 25 | 18          | 54   | 9           | 00   | 1           | 54   | 13           | 15   | 20         | 59   | 23          | 25   |
| 26 | 18          | 39   | 8           | 37   | 2           | 17   | 13           | 34   | 21         | 10   | 23          | 24   |
| 27 | 18          | 24   | 8           | 15   | 2           | 41   | 13           | 53   | 21         | 20   | 23          | 21   |
| 28 | 18          | 08   | 7           | 52   | 3           | 04   | 14           | 12   | 21         | 30   | 23          | 19   |
| 29 | 17          | 52   | —           | —    | 3           | 27   | 14           | 31   | 21         | 39   | 23          | 16   |
| 30 | 17          | 36   | —           | —    | 3           | 51   | 14           | 50   | 21         | 48   | 23          | 12   |
| 31 | 17          | 19   | —           | —    | 4           | 14   | —            | —    | 21         | 57   | —           | —    |

## TABLE I.

A TABLE of the *Sun's Declination* exactly calculated for the Year 1754, which (for the Use of Dialling) will serve for this Age without any sensible Error.

|    | July |      | Aug. |      | Sep. |      | Octob. |      | Novem. |      | Decemb. |      |
|----|------|------|------|------|------|------|--------|------|--------|------|---------|------|
|    | D.   | M.   | D.   | M.   | D.   | M.   | D.     | M.   | D.     | M.   | D.      | M.   |
| 1  | 23   | No 8 | 8    | No 2 | 8    | N 16 | 3      | S 15 | 14     | S 31 | 21      | S 53 |
| 2  | 23   | 04   | 17   | 47   | 7    | 54   | 3      | 38   | 14     | 50   | 22      | 02   |
| 3  | 22   | 59   | 17   | 31   | 7    | 32   | 4      | 01   | 15     | 09   | 22      | 10   |
| 4  | 22   | 54   | 17   | 15   | 7    | 10   | 4      | 24   | 15     | 28   | 22      | 18   |
| 5  | 22   | 49   | 16   | 59   | 6    | 47   | 4      | 48   | 15     | 46   | 22      | 26   |
| 6  | 22   | 43   | 16   | 43   | 6    | 25   | 5      | 11   | 16     | 04   | 22      | 33   |
| 7  | 22   | 37   | 16   | 26   | 6    | 03   | 5      | 34   | 16     | 22   | 22      | 40   |
| 8  | 22   | 30   | 16   | 09   | 5    | 40   | 5      | 57   | 16     | 40   | 22      | 47   |
| 9  | 22   | 23   | 15   | 52   | 5    | 17   | 6      | 20   | 16     | 57   | 22      | 53   |
| 10 | 22   | 16   | 15   | 34   | 4    | 55   | 6      | 48   | 17     | 14   | 22      | 58   |
| 11 | 22   | 08   | 15   | 17   | 4    | 32   | 7      | 05   | 17     | 31   | 23      | 03   |
| 12 | 22   | 00   | 14   | 59   | 4    | 09   | 7      | 28   | 17     | 47   | 23      | 08   |
| 13 | 21   | 51   | 14   | 40   | 3    | 46   | 7      | 51   | 18     | 03   | 23      | 12   |
| 14 | 21   | 42   | 14   | 22   | 3    | 23   | 8      | 13   | 18     | 19   | 23      | 16   |
| 15 | 21   | 33   | 14   | 03   | 2    | 59   | 8      | 35   | 18     | 34   | 23      | 19   |
| 16 | 21   | 23   | 13   | 44   | 2    | 36   | 8      | 58   | 18     | 49   | 23      | 22   |
| 17 | 21   | 13   | 13   | 25   | 2    | 13   | 9      | 20   | 19     | 04   | 23      | 24   |
| 18 | 21   | 03   | 13   | 06   | 1    | 50   | 9      | 42   | 19     | 19   | 23      | 26   |
| 19 | 20   | 52   | 12   | 46   | 1    | 26   | 10     | 03   | 19     | 33   | 23      | 27   |
| 20 | 20   | 41   | 12   | 27   | 1    | 03   | 10     | 25   | 19     | 46   | 23      | 28   |
| 21 | 20   | 30   | 12   | 07   | 0    | 40   | 10     | 47   | 20     | 00   | 23      | 29   |
| 22 | 20   | 18   | 11   | 47   | 0    | 16   | 11     | 08   | 20     | 13   | 23      | 29   |
| 23 | 20   | 06   | 11   | 26   | 0    | S 07 | 11     | 29   | 20     | 25   | 23      | 28   |
| 24 | 19   | 53   | 11   | 06   | 0    | 31   | 11     | 50   | 20     | 38   | 23      | 27   |
| 25 | 19   | 40   | 10   | 45   | 0    | 54   | 12     | 11   | 20     | 50   | 23      | 25   |
| 26 | 19   | 27   | 10   | 24   | 1    | 18   | 12     | 32   | 21     | 01   | 23      | 23   |
| 27 | 19   | 14   | 10   | 03   | 1    | 41   | 12     | 52   | 21     | 12   | 23      | 21   |
| 28 | 19   | 00   | 9    | 42   | 2    | 04   | 13     | 12   | 21     | 23   | 23      | 18   |
| 29 | 18   | 46   | 9    | 21   | 2    | 28   | 13     | 32   | 21     | 33   | 23      | 15   |
| 30 | 18   | 32   | 8    | 59   | 2    | 51   | 13     | 52   | 21     | 43   | 23      | 11   |
| 31 | 18   | 17   | 8    | 38   |      |      | 14     | 12   |        |      | 23      | 0    |



THE  
EXPLANATION *and* USE  
Of the foregoing  
T A B L E.

**T**HIS Table shews you the *Sun's Declination* \* every Day at Noon, and is exactly calculated to the Year 1754 to the *Meridian of London*, which will serve for *this Age near enough* for any Purpose in *Dialling*.

*Note*, D stands for Degrees, M for Minutes, N for North Declination, and S for South.

It is of good use to find the *Latitude of the Place* of your Habitation: this may be done by taking the height of the Sun at Noon with your *Quadrant*: and if the *Sun's Declination* be South, ADD it to the *Altitude* or Height at Noon, but if it be North SUBTRACT: the Sum or Difference is the *height* of the *Equinoctial* or *Complement of the Latitude* in the Northern Hemisphere, but in the Southern use the contrary Titles.

\* The *Declination of the Sun*, is his *Distance* from the *Equinoctial*, and in all Things of *this kind* the Sun is supposed to move *parallel* to the *Equinoctial* all that Day, and tho' it does not so in fact, yet it serves in *Dialling near enough* the Truth; and this *Declination* never exceeds 23 Deg. 29 Min. as appears by the Table.

*Example.*

Example.

Admit you are at a certain Place in the North of England, &c. and upon the 14th of February you observe the Sun's height at Noon with your Quadrant to be 22 Deg. 37 Min. what is the Latitude of Observation?

Operation.

|                                      |   |   |   | Deg. Min. |
|--------------------------------------|---|---|---|-----------|
| To the Sun's Altitude observed       | — | — | — | 22 37     |
| Add the Sun's Declination S.         | — | — | — | 12 56     |
| Sum is the height of the Equinoctial |   | — | — | 35 33     |
| Subtract it from a Quadrant or       | — | — | — | 90 00     |
| The Latitude of the Place North is   |   | — | — | 54 27     |

Example 2.

|                                        |   |   |   | Deg. Min. |
|----------------------------------------|---|---|---|-----------|
| From the Sun's Altitude observed       | — | — | — | 44 51     |
| Subtract the Sun's Declination North   | — | — | — | 10 53     |
| Remains the Complement of the Latitude |   | — | — | 33 58     |
| Subtract from a Quadrant or            | — | — | — | 90 00     |
| Remains the Latitude North             | — | — | — | 56 02     |

## T A B L E II.

A TABLE of the *Equation of Time* for *Regulating* Pendulum Clocks  
and Watches by a Sun Dial.

| Days | JAN. |    | FEB.  |    | MAR. |    | APR. |    | MAY |    | JUNE |    |
|------|------|----|-------|----|------|----|------|----|-----|----|------|----|
|      | M.   | S. | M.    | S. | M.   | S. | M.   | S. | M.  | S. | M.   | S. |
| 1    | 4    | 6  | 14    | 13 | 12   | 48 | 4    | 1  | 3   | 8  | 2    | 47 |
| 2    | 4    | 34 | 14    | 20 | 12   | 36 | 3    | 43 | 3   | 16 | 2    | 38 |
| 3    | 5    | 2  | 14    | 27 | 12   | 23 | 3    | 25 | 3   | 23 | 2    | 29 |
| 4    | 5    | 30 | 14    | 32 | 12   | 9  | 3    | 6  | 3   | 30 | 2    | 19 |
| 5    | 5    | 57 | 14    | 37 | 11   | 55 | 2    | 48 | 3   | 36 | 2    | 9  |
| 6    | 6    | 24 | 14    | 41 | 11   | 41 | 2    | 30 | 3   | 42 | 1    | 59 |
| 7    | 6    | 50 | 14    | 44 | 11   | 26 | 2    | 13 | 3   | 47 | 1    | 48 |
| 8    | 7    | 16 | 14    | 47 | 11   | 11 | 1    | 55 | 3   | 51 | 1    | 37 |
| 9    | 7    | 41 | 14    | 48 | 10   | 56 | 1    | 38 | 3   | 55 | 1    | 26 |
| 10   | 8    | 6  | 14    | 49 | 10   | 40 | 1    | 21 | 3   | 58 | 1    | 14 |
| 11   | 8    | 30 | 14    | 49 | 10   | 24 | 1    | 4  | 4   | 0  | 1    | 2  |
| 12   | 8    | 59 | 14    | 48 | 10   | 7  | 0    | 48 | 4   | 2  | 0    | 50 |
| 13   | 9    | 22 | 14    | 47 | 9    | 50 | 0    | 32 | 4   | 4  | 0    | 38 |
| 14   | 9    | 44 | 14    | 44 | 9    | 33 | 0    | 16 | 4   | 5  | 0    | 26 |
| 15   | 10   | 5  | 14    | 41 | 9    | 16 | 0    | 1  | 4   | 5  | 0    | 13 |
| 16   | 10   | 26 | 14    | 37 | 8    | 58 | 0    | 14 | 4   | 5  | 0    | 1  |
| 17   | 10   | 46 | 14    | 33 | 8    | 40 | 0    | 29 | 4   | 4  | 0    | 12 |
| 18   | 11   | 5  | 14    | 28 | 8    | 22 | 0    | 43 | 4   | 2  | 0    | 25 |
| 19   | 11   | 24 | 14    | 22 | 8    | 4  | 0    | 57 | 4   | 0  | 0    | 38 |
| 20   | 11   | 42 | 14    | 15 | 7    | 46 | 1    | 11 | 3   | 58 | 0    | 50 |
| 21   | 11   | 59 | 14    | 8  | 7    | 27 | 1    | 24 | 3   | 55 | 1    | 3  |
| 22   | 12   | 15 | 14    | 0  | 7    | 9  | 1    | 37 | 3   | 51 | 1    | 16 |
| 23   | 12   | 30 | 13    | 52 | 6    | 50 | 1    | 49 | 3   | 47 | 1    | 29 |
| 24   | 12   | 45 | 13    | 43 | 6    | 31 | 2    | 1  | 3   | 42 | 1    | 42 |
| 25   | 12   | 59 | 13    | 33 | 6    | 13 | 2    | 12 | 3   | 37 | 1    | 55 |
| 26   | 13   | 12 | 13    | 22 | 5    | 54 | 2    | 23 | 3   | 31 | 2    | 7  |
| 27   | 13   | 24 | 13    | 12 | 5    | 35 | 2    | 33 | 3   | 25 | 2    | 20 |
| 28   | 13   | 36 | 13    | 0  | 5    | 16 | 2    | 43 | 3   | 18 | 2    | 32 |
| 29   | 13   | 46 | ..... |    | 4    | 57 | 2    | 52 | 3   | 11 | 2    | 44 |
| 30   | 13   | 51 | ..... |    | 4    | 39 | 3    | 0  | 3   | 3  | 2    | 56 |
| 31   | 14   | 5  |       |    | 4    | 20 |      |    | 2   | 55 |      |    |



## T A B L E II.

A TABLE of the *Equation of Time* for *Regulating* Pendulum Clocks  
and Watches by a Sun-Dial.

| Days | JULY |    | AUG. |     | SEP. |    | OCT. |    | NOV. |    | DEC. |      |
|------|------|----|------|-----|------|----|------|----|------|----|------|------|
|      | M.   | S. | M.   | S.  | M.   | S. | M.   | S. | M.   | S. | M.   | S.   |
| 1    | 3    | 8  | 5    | 46  | 0    | 18 | 10   | 23 | 16   | 13 | 10   | 32   |
| 2    | 3    | 19 | 5    | 42  | 0    | 36 | 10   | 42 | 16   | 13 | 10   | 9    |
| 3    | 3    | 31 | 5    | 38  | 0    | 55 | 11   | 0  | 16   | 13 | 9    | 45   |
| 4    | 3    | 42 | 5    | 33  | 1    | 14 | 11   | 18 | 16   | 12 | 9    | 20   |
| 5    | 3    | 52 | 5    | 28  | 1    | 34 | 11   | 30 | 16   | 10 | 8    | 55   |
| 6    | 4    | 2  | 5    | 22  | 1    | 54 | 11   | 53 | 16   | 8  | 8    | 29   |
| 7    | 4    | 12 | 5    | 15  | 2    | 14 | 12   | 10 | 16   | 4  | 8    | 3    |
| 8    | 4    | 22 | 5    | 8   | 2    | 34 | 12   | 27 | 16   | 0  | 7    | 37   |
| 9    | 4    | 31 | 5    | 0   | 2    | 54 | 12   | 43 | 15   | 54 | 7    | 10   |
| 10   | 4    | 40 | 4    | 52  | 3    | 14 | 12   | 58 | 15   | 48 | 6    | 42   |
| 11   | 4    | 48 | 4    | 43  | 3    | 35 | 13   | 13 | 15   | 41 | 6    | 14   |
| 12   | 4    | 56 | 4    | 34  | 3    | 55 | 13   | 28 | 15   | 34 | 5    | 46   |
| 13   | 5    | 4  | 4    | 24  | 4    | 16 | 13   | 42 | 15   | 25 | 5    | 18   |
| 14   | 5    | 11 | 4    | 13  | 4    | 37 | 13   | 56 | 15   | 16 | 4    | 49   |
| 15   | 5    | 17 | 4    | 2   | 4    | 58 | 14   | 9  | 15   | 6  | 4    | 19   |
| 16   | 5    | 23 | 3    | 50  | 5    | 19 | 14   | 22 | 14   | 55 | 3    | 50   |
| 17   | 5    | 29 | 3    | 38  | 5    | 40 | 14   | 33 | 14   | 43 | 3    | 20   |
| 18   | 5    | 34 | 3    | 26  | 6    | 1  | 14   | 45 | 14   | 30 | 2    | 51   |
| 19   | 5    | 39 | 3    | 12  | 6    | 22 | 14   | 56 | 14   | 16 | 2    | 21   |
| 20   | 5    | 43 | 2    | 59  | 6    | 42 | 15   | 6  | 14   | 2  | 1    | 51   |
| 21   | 5    | 46 | 2    | 45  | 7    | 3  | 15   | 15 | 13   | 46 | 1    | 20   |
| 22   | 5    | 49 | 2    | 30  | 7    | 24 | 15   | 24 | 13   | 30 | 0    | 50   |
| 23   | 5    | 51 | 2    | 15  | 7    | 44 | 15   | 32 | 13   | 13 | 0    | * 20 |
| 24   | 5    | 53 | 2    | 0   | 8    | 5  | 15   | 40 | 12   | 56 | 0    | * 10 |
| 25   | 5    | 54 | 1    | 44  | 8    | 25 | 15   | 46 | 12   | 38 | 0    | 40   |
| 26   | 5    | 55 | 1    | 28  | 8    | 45 | 15   | 52 | 12   | 18 | 1    | 10   |
| 27   | 5    | 55 | 1    | 11  | 9    | 5  | 15   | 58 | 11   | 58 | 1    | 40   |
| 28   | 5    | 54 | 0    | 54  | 9    | 25 | 16   | 2  | 11   | 38 | 2    | 10   |
| 29   | 5    | 53 | 0    | 36  | 9    | 45 | 16   | 6  | 11   | 17 | 2    | 39   |
| 30   | 5    | 51 | 0    | 19  | 10   | 4  | 16   | 9  | 10   | 55 | 3    | 8    |
| 31   | 5    | 49 | 0    | * 1 |      |    | 16   | 11 |      |    | 3    | 37   |

EXPLANATION *and* USE

Of the foregoing

## T A B L E.

THIS is a Table of *Equation of Time*, that is, it shews you what the Sun *gains* or *loses* of the Pendulum Clock *every Day*; for the *Pendulum Clock* keeps *equal Time* all the Year round, tho' the Sun doth not do so, but is *very unequal* in its Motion, *sometimes too fast*, and at other Times *too slow*, as the Table plainly shews; so that if at any Time you want to set your *Clock* or *Watch* by your *Sun-Dial*, you must look into this Table, and observe what the *Equation* is on that Day, and set it accordingly, so many *Minutes* and *Seconds*, *faster* or *slower*, as you see the Clock is *too fast* or *too slow* for the Sun.

*For Instance, January 14 at Noon, I see the Clock is 9 Min. 44 Seconds too fast for the Sun, &c. Therefore the Clock should be set 9 Min. 44 Seconds faster than a Sun Dial.*

On *May the 10th, at Noon the Clock is 3 Min. 58 Seconds, too slow; therefore when it is twelve by a Sun Dial, the Clock must be set to 56 Min. 2 Seconds after Eleven.*

T A B L E





EXPLANATION *and* USE

Of the foregoing

## T A B L E.

THIS Table shews how to convert *Time into Motion*, and *Motion into Time*; as suppose I had 5 Hours 13 Min. 29 Seconds to be turned into *Degrees* and *Minutes* of the *Equinoctial*, i. e. into *Motion*; the *Operation* stands thus.

|            |   | D. | M. | S.       |             |
|------------|---|----|----|----------|-------------|
| 5 Hours    | = | 75 | 0  | 0        | } add       |
| 13 Minutes | = | 3  | 15 | 0        |             |
| 29 Seconds | = | 0  | 7  | 15       |             |
| The Sum    |   | —  | —  | 78 22 15 | for answer. |

Again, suppose I would turn 78 Deg. 22 Min. 15 Seconds into *Time*, then the Work will stand thus.

|                |    |    | H.    | M. | S. |             |
|----------------|----|----|-------|----|----|-------------|
| <i>Degrees</i> | 75 | == | 5     | 0  | 0  | } add       |
| <i>Degrees</i> | 3  | == | 0     | 12 | 0  |             |
| <i>Minutes</i> | 15 | == | 0     | 1  | 0  |             |
| <i>Minutes</i> | 7  | == | 0     | 1  | 28 |             |
| <i>Seconds</i> | 15 | == | 0     | 0  | 1  |             |
|                |    |    | <hr/> |    |    |             |
| The Sum        | —  | —  | 5     | 14 | 29 | for answer. |

N. B. There being the *same* Number, either of *Minutes*, *Seconds*, or *Thirds* in an *Hour*, as there are *Minutes*, *Seconds* or *Thirds* in a *Degree*; therefore the *Head* of each Column in the Table, is marked with *three* different Characters, that the *same* Column might serve for *either*. Thus against 12 in the *third* Column (marked at the Top with ' , '' , ''') stands 3. 0. in the *fourth* Column, and signifies either 3 *Degrees*, 3 *Minutes*, or 3 *Seconds*, according as the *first* signified either 12 *Minutes*, 12 *Seconds*, or 12 *Thirds*, and the same is to be understood of the rest.

TABLE

# TABLE IV.

A Table of Meridional Angles, shewing the Degrees of each Hour Line from 12 a-clock, upon all Horizontal and North and South Erect Direct Reclining and Inclining Dials, from the Equinoctial to the Poles.

| Hor. Dial Lat. | TABLE IV.                                                                                                                                                                                                   |    |      |    |        |    |         |    |       |    |    |    | South Dial Lat. |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|------|----|--------|----|---------|----|-------|----|----|----|-----------------|
|                | A Table of Meridional Angles, shewing the Degrees of each Hour Line from 12 a-clock, upon all Horizontal and North and South Erect Direct Reclining and Inclining Dials, from the Equinoctial to the Poles. |    |      |    |        |    |         |    |       |    |    |    |                 |
|                | XI I                                                                                                                                                                                                        |    | X II |    | IX III |    | VIII IV |    | VII V |    | VI |    |                 |
|                | D.                                                                                                                                                                                                          | M. | D.   | M. | D.     | M. | D.      | M. | D.    | M. | D. | M. |                 |
| 0              | 0                                                                                                                                                                                                           | 00 | 0    | 00 | 0      | 00 | 0       | 00 | 0     | 00 | 00 | 0  | 90              |
| 1              | 0                                                                                                                                                                                                           | 16 | 0    | 34 | 1      | 00 | 1       | 44 | 3     | 44 | 90 | 0  | 89              |
| 2              | 0                                                                                                                                                                                                           | 32 | 1    | 9  | 2      | 00 | 3       | 27 | 7     | 25 | 90 | 0  | 88              |
| 3              | 0                                                                                                                                                                                                           | 48 | 1    | 44 | 3      | 00 | 5       | 11 | 11    | 3  | 90 | 0  | 87              |
| 4              | 1                                                                                                                                                                                                           | 5  | 2    | 19 | 4      | 00 | 6       | 54 | 14    | 36 | 90 | 0  | 86              |
| 5              | 1                                                                                                                                                                                                           | 20 | 2    | 52 | 4      | 58 | 8       | 35 | 18    | 1  | 90 | 0  | 85              |
| 6              | 1                                                                                                                                                                                                           | 36 | 3    | 27 | 5      | 58 | 10      | 16 | 21    | 19 | 90 | 0  | 84              |
| 7              | 1                                                                                                                                                                                                           | 52 | 4    | 3  | 6      | 57 | 11      | 55 | 24    | 27 | 90 | 0  | 83              |
| 8              | 2                                                                                                                                                                                                           | 8  | 4    | 37 | 7      | 55 | 13      | 33 | 27    | 23 | 90 | 0  | 82              |
| 9              | 2                                                                                                                                                                                                           | 23 | 5    | 9  | 8      | 54 | 15      | 10 | 30    | 17 | 90 | 0  | 81              |
| 10             | 2                                                                                                                                                                                                           | 40 | 5    | 43 | 9      | 51 | 16      | 44 | 32    | 55 | 90 | 0  | 80              |
| 11             | 2                                                                                                                                                                                                           | 55 | 6    | 17 | 10     | 48 | 18      | 17 | 35    | 27 | 90 | 0  | 79              |
| 12             | 3                                                                                                                                                                                                           | 11 | 6    | 51 | 11     | 45 | 19      | 40 | 37    | 49 | 90 | 0  | 78              |
| 13             | 3                                                                                                                                                                                                           | 27 | 7    | 24 | 12     | 41 | 21      | 17 | 40    | 1  | 90 | 0  | 77              |
| 14             | 3                                                                                                                                                                                                           | 43 | 7    | 57 | 13     | 36 | 22      | 44 | 42    | 4  | 90 | 0  | 76              |
| 15             | 3                                                                                                                                                                                                           | 58 | 8    | 30 | 14     | 31 | 24      | 0  | 44    | 0  | 90 | 0  | 75              |
| 16             | 4                                                                                                                                                                                                           | 13 | 9    | 2  | 15     | 25 | 25      | 31 | 45    | 49 | 90 | 0  | 74              |
| 17             | 4                                                                                                                                                                                                           | 29 | 9    | 35 | 16     | 26 | 26      | 52 | 47    | 27 | 90 | 0  | 73              |
| 18             | 4                                                                                                                                                                                                           | 44 | 10   | 8  | 17     | 10 | 28      | 9  | 49    | 4  | 90 | 0  | 72              |
| 19             | 4                                                                                                                                                                                                           | 59 | 10   | 39 | 18     | 2  | 29      | 25 | 50    | 33 | 90 | 0  | 71              |
| 20             | 5                                                                                                                                                                                                           | 14 | 11   | 10 | 18     | 53 | 30      | 39 | 51    | 55 | 90 | 0  | 70              |
| 21             | 5                                                                                                                                                                                                           | 29 | 11   | 41 | 19     | 44 | 31      | 50 | 53    | 9  | 90 | 0  | 69              |
| 22             | 5                                                                                                                                                                                                           | 44 | 12   | 12 | 20     | 32 | 32      | 58 | 54    | 21 | 90 | 0  | 68              |
| 23             | 5                                                                                                                                                                                                           | 59 | 12   | 43 | 21     | 20 | 34      | 5  | 55    | 30 | 90 | 0  | 67              |
| 24             | 6                                                                                                                                                                                                           | 14 | 13   | 13 | 22     | 8  | 35      | 10 | 56    | 37 | 90 | 0  | 66              |
| 25             | 6                                                                                                                                                                                                           | 28 | 13   | 43 | 22     | 55 | 36      | 12 | 57    | 34 | 90 | 0  | 65              |
| 26             | 6                                                                                                                                                                                                           | 42 | 14   | 12 | 23     | 40 | 37      | 13 | 58    | 34 | 90 | 0  | 64              |
| 27             | 6                                                                                                                                                                                                           | 56 | 14   | 41 | 24     | 25 | 38      | 11 | 59    | 27 | 90 | 0  | 63              |
| 28             | 7                                                                                                                                                                                                           | 10 | 15   | 10 | 25     | 9  | 39      | 7  | 60    | 17 | 90 | 0  | 62              |
| 29             | 7                                                                                                                                                                                                           | 24 | 15   | 40 | 25     | 52 | 40      | 2  | 61    | 4  | 90 | 0  | 61              |
| 30             | 7                                                                                                                                                                                                           | 38 | 16   | 6  | 26     | 32 | 40      | 54 | 61    | 49 | 90 | 0  | 60              |

# TABLE IV.

A Table of Meridional Angles, shewing the Degrees of each Hour Line from 12 a-clock, upon all Horizontal and North and South Erect Direct Reclining and Inclining Dials, from the Equinoctial to the Poles.

| A Table of Meridional Angles, shewing the Degrees of each Hour Line from 12 a-clock, upon all Horizontal and North and South Erect Direct Reclining and Inclining Dials, from the Equinoctial to the Poles. |    |    |    |    |    |    |      |    |     |    |    |    |                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|----|----|----|------|----|-----|----|----|----|-----------------|
| Hor. Dial Lat.                                                                                                                                                                                              | XI |    | X  |    | IX |    | VIII |    | VII |    | VI |    | South Dial Lat. |
|                                                                                                                                                                                                             | D. | M. | D. | M. | D. | M. | D.   | M. | D.  | M. | D. | M. |                 |
| 31                                                                                                                                                                                                          | 7  | 50 | 16 | 34 | 27 | 15 | 41   | 44 | 62  | 30 | 90 | 0  | 59              |
| 32                                                                                                                                                                                                          | 8  | 5  | 17 | 1  | 27 | 55 | 42   | 30 | 63  | 11 | 90 | 0  | 58              |
| 33                                                                                                                                                                                                          | 8  | 19 | 17 | 27 | 28 | 34 | 43   | 20 | 63  | 49 | 90 | 0  | 57              |
| 34                                                                                                                                                                                                          | 8  | 31 | 17 | 54 | 29 | 13 | 44   | 5  | 64  | 24 | 90 | 0  | 56              |
| 35                                                                                                                                                                                                          | 8  | 44 | 18 | 20 | 29 | 50 | 44   | 49 | 64  | 58 | 90 | 0  | 55              |
| 36                                                                                                                                                                                                          | 8  | 57 | 18 | 49 | 30 | 27 | 45   | 31 | 65  | 30 | 90 | 0  | 54              |
| 37                                                                                                                                                                                                          | 9  | 10 | 19 | 9  | 31 | 2  | 46   | 12 | 66  | 10 | 90 | 0  | 53              |
| 38                                                                                                                                                                                                          | 9  | 22 | 19 | 34 | 31 | 37 | 46   | 50 | 66  | 29 | 90 | 0  | 52              |
| 39                                                                                                                                                                                                          | 9  | 34 | 19 | 58 | 32 | 11 | 47   | 28 | 66  | 56 | 90 | 0  | 51              |
| 40                                                                                                                                                                                                          | 9  | 45 | 20 | 21 | 32 | 44 | 48   | 7  | 67  | 21 | 90 | 0  | 50              |
| 41                                                                                                                                                                                                          | 9  | 57 | 20 | 44 | 33 | 16 | 48   | 39 | 67  | 47 | 90 | 0  | 49              |
| 42                                                                                                                                                                                                          | 10 | 10 | 21 | 7  | 33 | 46 | 49   | 12 | 68  | 11 | 90 | 0  | 48              |
| 43                                                                                                                                                                                                          | 10 | 22 | 21 | 29 | 34 | 18 | 49   | 44 | 68  | 33 | 90 | 0  | 47              |
| 44                                                                                                                                                                                                          | 10 | 32 | 21 | 51 | 34 | 47 | 50   | 10 | 68  | 54 | 90 | 0  | 46              |
| 45                                                                                                                                                                                                          | 10 | 44 | 22 | 12 | 35 | 17 | 50   | 46 | 69  | 15 | 90 | 0  | 45              |
| 46                                                                                                                                                                                                          | 10 | 54 | 22 | 33 | 35 | 44 | 51   | 15 | 69  | 35 | 90 | 0  | 44              |
| 47                                                                                                                                                                                                          | 11 | 5  | 22 | 53 | 36 | 11 | 51   | 42 | 69  | 53 | 90 | 0  | 43              |
| 48                                                                                                                                                                                                          | 11 | 16 | 23 | 13 | 36 | 37 | 52   | 9  | 70  | 11 | 90 | 0  | 42              |
| 49                                                                                                                                                                                                          | 11 | 25 | 23 | 33 | 37 | 3  | 52   | 35 | 70  | 28 | 90 | 0  | 41              |
| 50                                                                                                                                                                                                          | 11 | 35 | 23 | 52 | 37 | 28 | 53   | 0  | 70  | 43 | 90 | 0  | 40              |
| 51                                                                                                                                                                                                          | 11 | 45 | 24 | 9  | 37 | 52 | 53   | 24 | 70  | 59 | 90 | 0  | 39              |
| 52                                                                                                                                                                                                          | 11 | 55 | 24 | 27 | 38 | 15 | 53   | 46 | 71  | 13 | 90 | 0  | 38              |
| 53                                                                                                                                                                                                          | 12 | 5  | 24 | 43 | 38 | 37 | 54   | 12 | 71  | 28 | 90 | 0  | 37              |
| 54                                                                                                                                                                                                          | 12 | 13 | 25 | 2  | 38 | 58 | 54   | 29 | 71  | 41 | 90 | 0  | 36              |
| 55                                                                                                                                                                                                          | 12 | 22 | 25 | 18 | 39 | 19 | 54   | 49 | 71  | 54 | 90 | 0  | 35              |
| 56                                                                                                                                                                                                          | 12 | 32 | 25 | 34 | 39 | 40 | 55   | 9  | 72  | 5  | 90 | 0  | 34              |
| 57                                                                                                                                                                                                          | 12 | 40 | 25 | 50 | 39 | 50 | 55   | 28 | 72  | 17 | 90 | 0  | 33              |
| 58                                                                                                                                                                                                          | 12 | 45 | 26 | 5  | 40 | 1  | 55   | 45 | 72  | 28 | 90 | 0  | 32              |
| 59                                                                                                                                                                                                          | 12 | 56 | 26 | 20 | 40 | 36 | 56   | 3  | 72  | 38 | 90 | 0  | 31              |
| 60                                                                                                                                                                                                          | 13 | 4  | 26 | 34 | 40 | 54 | 56   | 19 | 72  | 48 | 90 | 0  | 30              |



# TABLE IV.

A Table of *Meridional Angles*, shewing the *Degrees* of each *Hour-Line* from 12 a-clock, upon all *Horizontal* and *North* and *South* Erect Direct *Reclining* and *Inclining* Dials, from the *Equinoctial* to the *Poles*.

| Hor. Dial Lat. | XI |    | I X |    | II IX |    | III VIII |    | IV VII |    | V VI |    | South Dial Lat. |
|----------------|----|----|-----|----|-------|----|----------|----|--------|----|------|----|-----------------|
|                | D. | M. | D.  | M. | D.    | M. | D.       | M. | D.     | M. | D.   | M. |                 |
| 61             | 13 | 11 | 26  | 47 | 41    | 10 | 56       | 34 | 72     | 58 | 90   | 0  | 29              |
| 62             | 13 | 19 | 27  | 1  | 41    | 21 | 56       | 49 | 73     | 7  | 90   | 0  | 28              |
| 63             | 13 | 26 | 27  | 13 | 41    | 42 | 57       | 3  | 73     | 15 | 90   | 0  | 27              |
| 64             | 13 | 32 | 27  | 25 | 41    | 57 | 57       | 17 | 73     | 24 | 90   | 0  | 26              |
| 65             | 13 | 36 | 27  | 37 | 42    | 15 | 57       | 30 | 73     | 32 | 90   | 0  | 25              |
| 66             | 13 | 46 | 27  | 49 | 42    | 25 | 57       | 43 | 73     | 39 | 90   | 0  | 24              |
| 67             | 13 | 51 | 27  | 59 | 42    | 38 | 57       | 54 | 73     | 46 | 90   | 0  | 23              |
| 68             | 13 | 57 | 28  | 9  | 43    | 50 | 68       | 5  | 73     | 53 | 90   | 0  | 22              |
| 69             | 14 | 3  | 28  | 19 | 43    | 2  | 58       | 16 | 73     | 59 | 90   | 0  | 21              |
| 70             | 14 | 7  | 28  | 29 | 43    | 13 | 58       | 26 | 74     | 5  | 90   | 0  | 20              |
| 71             | 14 | 13 | 28  | 37 | 43    | 19 | 58       | 35 | 74     | 11 | 90   | 0  | 19              |
| 72             | 14 | 18 | 28  | 46 | 43    | 24 | 58       | 54 | 74     | 16 | 90   | 0  | 18              |
| 73             | 14 | 22 | 28  | 54 | 43    | 36 | 58       | 52 | 74     | 20 | 90   | 0  | 17              |
| 74             | 14 | 27 | 29  | 2  | 43    | 52 | 59       | 00 | 74     | 25 | 90   | 0  | 16              |
| 75             | 14 | 30 | 29  | 7  | 44    | 00 | 59       | 7  | 74     | 30 | 90   | 0  | 15              |
| 76             | 14 | 33 | 29  | 15 | 44    | 8  | 59       | 15 | 74     | 34 | 90   | 0  | 14              |
| 77             | 14 | 37 | 29  | 21 | 44    | 14 | 59       | 22 | 74     | 37 | 90   | 0  | 13              |
| 78             | 14 | 41 | 29  | 27 | 44    | 22 | 59       | 27 | 74     | 40 | 90   | 0  | 12              |
| 79             | 14 | 44 | 29  | 32 | 44    | 28 | 59       | 32 | 74     | 44 | 90   | 0  | 11              |
| 80             | 14 | 47 | 29  | 37 | 44    | 34 | 59       | 37 | 74     | 47 | 90   | 0  | 10              |
| 81             | 14 | 49 | 29  | 41 | 44    | 37 | 59       | 40 | 74     | 49 | 90   | 0  | 9               |
| 82             | 14 | 51 | 29  | 45 | 44    | 40 | 59       | 44 | 74     | 51 | 90   | 0  | 8               |
| 83             | 14 | 53 | 29  | 49 | 44    | 44 | 59       | 47 | 74     | 53 | 90   | 0  | 7               |
| 84             | 14 | 55 | 29  | 52 | 44    | 48 | 59       | 51 | 74     | 55 | 90   | 0  | 5               |
| 85             | 14 | 56 | 29  | 54 | 44    | 53 | 59       | 54 | 74     | 57 | 90   | 0  | 5               |
| 86             | 14 | 57 | 29  | 55 | 44    | 55 | 59       | 55 | 74     | 58 | 90   | 0  | 4               |
| 87             | 14 | 58 | 29  | 56 | 44    | 56 | 59       | 56 | 74     | 58 | 90   | 0  | 3               |
| 88             | 14 | 59 | 29  | 57 | 44    | 57 | 59       | 58 | 74     | 59 | 90   | 0  | 2               |
| 89             | 14 | 59 | 29  | 58 | 44    | 58 | 59       | 59 | 74     | 59 | 90   | 0  | 1               |
| 90             | 15 | 00 | 30  | 00 | 45    | 00 | 60       | 00 | 75     | 00 | 90   | 0  | 0               |

EXPLANATION *and* USE

Of the foregoing

## T A B L E,

THIS is a Table of *Meridional Angles*; the *first Column* is the *Latitude*, which serves for an *Horizontal Dial*, and the *last Column* is the *Complement of the Latitude*, and is for making *Erect Direct SOUTH or NORTH Dials*, and are thus to be used:

 Suppose in the *Latitude* of 53 *Deg.* I would make an *Horizontal*, and also an *Erect Direct South Dial*.

First, *For the Horizontal Dial.*

See Plate 3. Fig. 2.

Now (altho' this be projected for a *higher Latitude*, yet it may serve our Turn here well enough to shew how to use the Table:) I look into the Table, and find against 53 *Deg.* and under 11 and 1 a-clock 12 *Deg. 5 Min.* Take this 12 *Deg. 5 Min.* in your Compasses (from the *Line of Chords*, that you draw the *Quadrant AB* by) and set one foot in the *Meridian CA*, and turning the *other* each Way, it shall give the *Points* where the *Hour Lines* of 1 and 11 must pass; under 10 and 2, and against the *same Latitude 53*, I find 24 *Deg. 43 Min.* which take from the *Line of Chords*, and set *each Way* from the *Meridian*

## Ch. XIX. *The Explanation and Use, &c.* 81

*Meridian* as before, and it gives the 10 and 2 a-clock *Hour Lines*. For the Hours 9 and 3 you must take 38 Deg. 37 Min. for 8 and 4 a-clock, you must set 54 Deg. 12 Min. and for 5 and 7 set 71 Deg. 28 Min. the *Chord* of 90 gives the 6 a-clock *Hour Line*, and so by drawing *Hour Lines* from the Center thro' these Points, thus set off in the *Arch AB*, are the true *Hour Lines* required.

Secondly, *For the Erect Direct South Dial.*

See Plate 4. Fig. 2.

Suppose I would make an *Erect Direct South Dial* for the *Latitude* of 53 Deg. the Work in this is the very same as I have shewn in the *Horizontal Dial*; only here you must seek your *Latitude* in the last Column on the right Hand, or its *Complement* on the left Hand; and against either, for 11 and 1 a-clock, 9 Deg. 10 Min. for 10 and 2, 19 Deg. 9 Min. are to be set off from the *Meridian* by your *Line of Chords*; for 9 and 3 a-clock are 31 Deg. 2 Min. for 8 and 4 a-clock are 46 Deg. 12 Min. for 7 and 5 a-clock are 66 Deg. 10 Min. and for 6 a-clock are 90; and thus for any *Latitude* of even Degrees, an *Horizontal* and *South Direct Dial* may be expeditiously made by help of this *Table* and your *Line of Chords*.

What has been said of the *South Erect Dial* is also applicable to the *North*, and therefore needs no Example.

G

T A B L E



## T A B L E V.

A TABLE of the *Three Requisites* in *Dialing*, shewing the *Substile's Distance* from the *Meridian*, the *Stile's Height*, and the *Inclination*

| Declination. | Substile's Distance<br>from the <i>Meridian</i> . |    | STILE's<br>Height. | Inclination of <i>Me-<br/>ridians</i> . |    |
|--------------|---------------------------------------------------|----|--------------------|-----------------------------------------|----|
| Degrees.     | Degrees.Minutes.                                  |    | Deg.Min.           | Degrees.Minutes.                        |    |
| 1            | 0                                                 | 48 | 38 29              | 1                                       | 17 |
| 2            | 1                                                 | 36 | 38 28              | 2                                       | 33 |
| 3            | 2                                                 | 23 | 38 26              | 3                                       | 49 |
| 4            | 3                                                 | 11 | 38 23              | 5                                       | 7  |
| 5            | 3                                                 | 58 | 38 20              | 6                                       | 22 |
| 6            | 4                                                 | 45 | 38 15              | 7                                       | 39 |
| 7            | 5                                                 | 32 | 38 10              | 8                                       | 55 |
| 8            | 6                                                 | 19 | 38 4               | 10                                      | 11 |
| 9            | 7                                                 | 5  | 37 57              | 11                                      | 27 |
| 10           | 7                                                 | 52 | 37 49              | 12                                      | 42 |
| 11           | 8                                                 | 38 | 37 40              | 13                                      | 57 |
| 12           | 9                                                 | 23 | 37 30              | 15                                      | 10 |
| 13           | 10                                                | 8  | 37 21              | 16                                      | 26 |
| 14           | 10                                                | 54 | 37 10              | 17                                      | 40 |
| 15           | 11                                                | 38 | 36 58              | 18                                      | 54 |
| 16           | 12                                                | 22 | 36 43              | 20                                      | 7  |
| 17           | 13                                                | 5  | 36 32              | 21                                      | 20 |
| 18           | 13                                                | 42 | 36 18              | 22                                      | 33 |
| 19           | 14                                                | 31 | 36 3               | 23                                      | 45 |
| 20           | 15                                                | 13 | 35 48              | 24                                      | 57 |
| 21           | 15                                                | 54 | 35 31              | 26                                      | 8  |
| 22           | 16                                                | 36 | 35 16              | 27                                      | 18 |
| 23           | 17                                                | 16 | 34 57              | 28                                      | 29 |
| 24           | 17                                                | 56 | 34 39              | 29                                      | 38 |
| 25           | 18                                                | 37 | 34 21              | 30                                      | 47 |

## T A B L E V.

*tion of Meridians for the Latitude of London, answerable to the several Degrees of Declination of your Plane. N. B. How to find these Requisites for any other Place, is shewn in Chap. XI.*

| Declination. | Substile's Distance from the Meridian. |    | STILE's Height. |    | Inclination of Meridians. |    |
|--------------|----------------------------------------|----|-----------------|----|---------------------------|----|
| Degrees.     | Degrees.Minutes.                       |    | Deg.Min.        |    | Degrees.Minutes.          |    |
| 26           | 19                                     | 12 | 34              | 1  | 31                        | 56 |
| 27           | 19                                     | 50 | 33              | 42 | 33                        | 4  |
| 28           | 20                                     | 27 | 33              | 20 | 34                        | 12 |
| 29           | 21                                     | 5  | 32              | 59 | 35                        | 19 |
| 30           | 21                                     | 40 | 32              | 37 | 36                        | 25 |
| 31           | 22                                     | 15 | 32              | 15 | 37                        | 31 |
| 32           | 22                                     | 50 | 31              | 52 | 38                        | 36 |
| 33           | 23                                     | 25 | 31              | 27 | 39                        | 41 |
| 34           | 23                                     | 59 | 31              | 4  | 40                        | 46 |
| 35           | 24                                     | 31 | 30              | 40 | 41                        | 49 |
| 36           | 25                                     | 4  | 30              | 14 | 42                        | 52 |
| 37           | 25                                     | 35 | 29              | 48 | 43                        | 55 |
| 38           | 26                                     | 4  | 29              | 22 | 44                        | 58 |
| 39           | 26                                     | 35 | 28              | 56 | 45                        | 59 |
| 40           | 27                                     | 3  | 28              | 29 | 47                        | 0  |
| 41           | 27                                     | 33 | 28              | 1  | 48                        | 0  |
| 42           | 28                                     | 1  | 27              | 33 | 49                        | 0  |
| 43           | 28                                     | 29 | 27              | 5  | 50                        | 0  |
| 44           | 28                                     | 55 | 26              | 36 | 50                        | 59 |
| 45           | 29                                     | 21 | 26              | 7  | 51                        | 57 |
| 46           | 29                                     | 46 | 25              | 37 | 52                        | 55 |
| 47           | 30                                     | 11 | 25              | 7  | 53                        | 53 |
| 48           | 30                                     | 35 | 24              | 38 | 54                        | 50 |
| 49           | 30                                     | 58 | 24              | 6  | 55                        | 46 |
| 50           | 1                                      | 21 | 23              | 35 | 56                        | 42 |

## T A B L E V.

A TABLE of the *Three Requisites* in *Dialing*, shewing the *Substile's Distance* from the *Meridian*, the *Stile's Height*, and the *Inclina-*

| Declination. | Substile's Distance<br>from the <i>Meridian</i> . |    | STILE's<br>Height. | Inclination of <i>Me-</i><br><i>ridians</i> . |    |
|--------------|---------------------------------------------------|----|--------------------|-----------------------------------------------|----|
| Degrees.     | Degrees. Minutes.                                 |    | Deg.Min.           | Degrees. Minutes.                             |    |
| 51           | 31                                                | 45 | 23 4               | 57                                            | 38 |
| 52           | 32                                                | 5  | 22 32              | 58                                            | 33 |
| 53           | 32                                                | 26 | 22 00              | 59                                            | 28 |
| 54           | 32                                                | 46 | 21 28              | 60                                            | 23 |
| 55           | 33                                                | 6  | 20 55              | 61                                            | 17 |
| 56           | 33                                                | 24 | 20 22              | 62                                            | 10 |
| 57           | 33                                                | 42 | 19 49              | 63                                            | 4  |
| 58           | 34                                                | 0  | 19 16              | 63                                            | 57 |
| 59           | 34                                                | 13 | 18 42              | 64                                            | 49 |
| 60           | 34                                                | 33 | 18 6               | 65                                            | 41 |
| 61           | 34                                                | 47 | 17 34              | 66                                            | 33 |
| 62           | 35                                                | 5  | 17 0               | 67                                            | 24 |
| 63           | 35                                                | 18 | 16 25              | 68                                            | 16 |
| 64           | 35                                                | 32 | 15 50              | 69                                            | 7  |
| 65           | 35                                                | 45 | 15 15              | 69                                            | 57 |
| 66           | 36                                                | 00 | 14 40              | 70                                            | 47 |
| 67           | 36                                                | 13 | 14 5               | 71                                            | 38 |
| 68           | 36                                                | 25 | 13 29              | 72                                            | 27 |
| 69           | 36                                                | 36 | 12 53              | 73                                            | 16 |
| 70           | 36                                                | 45 | 12 11              | 74                                            | 6  |



TABLE V.

*tion of Meridians for the Latitude of London, answerable to the several Degrees of Declination of your Plane. N. B. How to find these Requisites for any other Place, is shewn in Chap. XI.*

| Declination. | Subfile's Distance from the Meridian. |    | STILE's Height. | Inclination of Meridians. |    |
|--------------|---------------------------------------|----|-----------------|---------------------------|----|
| Degrees.     | Degrees. Minutes.                     |    | Deg. Min.       | Degrees. Minutes          |    |
| 71           | 36                                    | 55 | 11 41           | 74                        | 55 |
| 72           | 37                                    | 6  | 11 6            | 75                        | 44 |
| 73           | 37                                    | 15 | 10 29           | 76                        | 33 |
| 74           | 37                                    | 24 | 9 53            | 77                        | 21 |
| 75           | 37                                    | 32 | 9 16            | 78                        | 9  |
| 76           | 37                                    | 40 | 8 40            | 78                        | 57 |
| 77           | 37                                    | 47 | 8 3             | 79                        | 46 |
| 78           | 37                                    | 53 | 7 27            | 80                        | 33 |
| 79           | 37                                    | 59 | 6 49            | 81                        | 21 |
| 80           | 38                                    | 4  | 6 12            | 82                        | 00 |
| 81           | 38                                    | 9  | 5 35            | 82                        | 30 |
| 82           | 38                                    | 14 | 4 56            | 83                        | 43 |
| 83           | 38                                    | 17 | 4 20            | 84                        | 31 |
| 84           | 38                                    | 21 | 3 44            | 85                        | 18 |
| 85           | 38                                    | 23 | 3 6             | 86                        | 5  |
| 86           | 38                                    | 26 | 2 28            | 86                        | 52 |
| 87           | 38                                    | 28 | 1 52            | 87                        | 39 |
| 88           | 38                                    | 29 | 1 15            | 88                        | 26 |
| 89           | 38                                    | 29 | 0 37            | 89                        | 13 |
| 90           | 38                                    | 30 | 0 00            | 90                        | 00 |

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THE  
EXPLANATION *and* USE  
Of the foregoing  
T A B L E.

**L**ASTLY, The Table of the *Three Requisites in Dialling* is explained in Chap. XI. where I have shewn how to find the *Substile's Distance* from the *Meridian*, the *Stile's height*, and the *Inclination of Meridians* for *Latitude 53 Deg. 22 Min.* and the *Plane's Declination 21 Deg. 10 Min. West*, which may serve as a *standing Rule* for any other *Latitude* and *Declination* whatsoever.

TABLE

## TABLE VI.

A TABLE shewing the *Sun's Altitude* every *Hour and Quarter* of the *Day*, at his Entrance into the 12 *Signs* of the *Zodiack* for the *Latitude* of *London 51 Deg. 32 Min. North*.

N. B. This Table is useful in drawing *reflective Dials*.

| Hours.  | ♈     | ♉     | ♊     | ♋     | ♌     | ♍     | ♎     | ♏     | ♐     | ♑     | ♒     | ♓     | ♈     |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|         | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. | D. M. |
| At 11   | 01 57 | 58 39 | 49 58 | 38 20 | 26 58 | 18 17 | 14 59 |       |       |       |       |       |       |
| 1       | 61 48 | 58 34 | 49 52 | 38 22 | 26 52 | 18 10 | 14 52 |       |       |       |       |       |       |
| 2       | 61 22 | 58 08 | 49 32 | 38 04 | 26 37 | 17 56 | 14 39 |       |       |       |       |       |       |
| 3       | 60 39 | 57 27 | 48 57 | 37 36 | 26 12 | 17 34 | 14 18 |       |       |       |       |       |       |
| I XI    | 59 42 | 56 33 | 48 10 | 36 50 | 25 37 | 17 03 | 13 48 |       |       |       |       |       |       |
| 1       | 58 29 | 55 25 | 47 11 | 36 05 | 24 53 | 16 24 | 13 09 |       |       |       |       |       |       |
| 2       | 57 04 | 54 06 | 46 01 | 35 04 | 24 01 | 15 36 | 12 23 |       |       |       |       |       |       |
| 3       | 55 29 | 52 34 | 44 40 | 33 50 | 22 59 | 14 19 | 11 29 |       |       |       |       |       |       |
| II X    | 53 45 | 50 55 | 43 11 | 32 36 | 21 49 | 13 36 | 10 28 |       |       |       |       |       |       |
| 1       | 51 53 | 49 07 | 41 52 | 31 08 | 20 31 | 12 24 | 9 19  |       |       |       |       |       |       |
| 2       | 49 54 | 47 12 | 39 37 | 29 34 | 19 06 | 11 06 | 8 03  |       |       |       |       |       |       |
| 3       | 47 51 | 45 13 | 37 57 | 27 53 | 17 36 | 9 42  | 6 41  |       |       |       |       |       |       |
| III IX  | 15 42 | 43 07 | 35 59 | 26 05 | 15 57 | 8 11  | 5 13  |       |       |       |       |       |       |
| 1       | 43 31 | 40 58 | 33 57 | 24 12 | 14 13 | 6 34  | 3 39  |       |       |       |       |       |       |
| 2       | 41 15 | 38 45 | 31 49 | 22 25 | 12 23 | 4 51  | 1 59  |       |       |       |       |       |       |
| 3       | 38 59 | 36 30 | 29 40 | 20 13 | 10 30 | 3 05  | 0 15  |       |       |       |       |       |       |
| IV VIII | 36 40 | 34 14 | 27 28 | 18 07 | 8 32  | 1 13  |       |       |       |       |       |       |       |
| 1       | 34 23 | 31 50 | 25 13 | 15 58 | 6 31  |       |       |       |       |       |       |       |       |
| 2       | 32 04 | 29 37 | 22 56 | 13 46 | 4 25  |       |       |       |       |       |       |       |       |
| 3       | 29 43 | 27 16 | 20 37 | 11 32 | 2 16  |       |       |       |       |       |       |       |       |
| V VII   | 27 23 | 24 56 | 18 18 | 9 17  | 0 05  |       |       |       |       |       |       |       |       |
| 1       | 25 04 | 22 37 | 15 59 | 6 58  |       |       |       |       |       |       |       |       |       |
| 2       | 22 46 | 20 17 | 13 39 | 4 39  |       |       |       |       |       |       |       |       |       |
| 3       | 20 28 | 17 57 | 11 19 | 2 20  |       |       |       |       |       |       |       |       |       |
| VI VI   | 18 12 | 15 42 | 9 00  |       |       |       |       |       |       |       |       |       |       |
| 1       | 15 58 | 14 00 | 6 44  |       |       |       |       |       |       |       |       |       |       |
| 2       | 13 46 | 11 13 | 4 22  |       |       |       |       |       |       |       |       |       |       |
| 3       | 11 37 | 9 01  | 2 08  |       |       |       |       |       |       |       |       |       |       |
| VII V   | 9 30  | 6 52  |       |       |       |       |       |       |       |       |       |       |       |
| 1       | 7 25  | 4 46  |       |       |       |       |       |       |       |       |       |       |       |
| 2       | 5 24  | 2 42  |       |       |       |       |       |       |       |       |       |       |       |
| 3       | 3 27  | 0 43  |       |       |       |       |       |       |       |       |       |       |       |
| VIII IV | 1 34  |       |       |       |       |       |       |       |       |       |       |       |       |



EXPLANATION *and* USE

Of the foregoing

## T A B L E.

**T**HIS Table shews the *Sun's Height* or *Altitude* at every *Hour* and *Quarter* of the Day, for the *Latitude* of *London*, and is useful in drawing *Hour Lines* upon your *Quadrant*,\* and *also* for drawing the *Hour Lines* upon the *Cieling* of your Room in the *Reflective Dial*, and by your *Quadrant* you may find the *Sun's Altitude* at *any Time* of the Day wherever you are, by holding your *Quadrant* up and looking through the *Sights* at the *Sun*, and the *Thread* will cut the *Limb* or *Arch* of the *Quadrant* in the *Degrees* of the *Sun's height* at that *Time* and *Place*; the *Minutes* must be *guessed at*, because every *Degree* being supposed to be *divided* into 60 *equal Parts* called *Minutes*, and those *Divisions* called *Degrees* being *small*, it is impossible they should *actually* be divided into *Minutes* or 60 *equal Parts*, so that if the *Thread* cuts a *Quarter* of a *Degree*, then call the *Minutes* 15, if it cuts *one Third* of a *Degree*, call them 20 *Minutes*, if a *half* 30, if *two Thirds* 40, if *three Fourths*, then the *Minutes* are 45, &c. and thus you may take the *Height* of the *Moon* and *Stars*. And by this means you may make the like Table for your *own* or any other *Latitude*.

\* For further Satisfaction herein you may see my *System of Astronomy*, Vol. I. Page 111.

CHAP. XX. *Shewing the Use of the Scales in Plate II.*

IN *Prob. 9, 10, 11 and 12*, I have shewn how to make the *Scales* in *Plate II*, and in *Chap. XVI. Page 56*, I have shewn how to use the *Line of Chords*, in measuring of any *right lined Angles*. The *Lines of Hours* and *Latitudes* are general for pricking down all *Dials with Centers*, as the *Horizontal, South Direct, &c.* as for

*Example.*

Let it be required to draw a *Dial* upon an *Horizontal Plane* for the *Latitude of London 51 Deg. 32 Min.*

See *Plate II. Fig. 1.*

*For the Hour Lines and Stile's height.*

Draw *CD* for the *Meridian*, or *Hour Line* of *12*, and cross it at *right Angles* in *C*, with *AB*; then from the *Scale of Latitudes*, set off *CA* and *CB* each equal to *51 Deg. 32 Min.* for the *Stile's height*. Then take the *whole Scale of Six Hours* in your *Compasses*, and set it from *A* to *D*; draw *AD* and *BD*: Divide the *Lines AD* and *BD* as the *Scale of six Hours* is divided, and thro' those *Divisions* draw *Lines* to the *Center C*, which shall be the true *Hour Lines* sought, to which put their *proper Figures* as you see done in the *Dial*.

This is a very ready and easy way to describe the *Hour Lines* on any *Plane*.

*For*

*For the Stile.*

Take C A in your Compasses, and set from D to E, draw C E for the *Stile*, which must stand *perpendicular* upon the Line C D, and so is your Dial completely finished.

Ever remember to make an Allowance for the *Thicknes* of the *Stile* in all Dials, as I have cautioned you before.

*An Example.*

Of a *North* and *South* Erect Direct Dial for *Penzance* in *Cornwall*, whose *Latitude* is 50 Deg. 8 Min. N.

See Plate 11. Fig. 2.

This Dial is made the very same Way as I have just now shewn in the *Horizontal Dial*, only instead of taking the *Latitude* from the *Scale of Latitudes*, you must here in this Dial take the *Complement of the Latitude of the Place*, viz. 39 Deg. 52 Min. and set it from C to A, and B, which is also the *Stile's height*.

*For the Hour Lines of the South and North Dials.*

Take the *Scale of six Hours*, and set from A to D, draw A D and B D, then take in your Compasses *each Hour severally* from the *Scale of six Hours*, and mark them off in the Lines A D and B D; *thro' those Points*, draw Lines from the *Center C*, and they shall be the *true Hour Lines* required.

*For the Stile.*

Set A C from D to E, and continue it *beyond the Center C*, which shall be the *Stiles* for the *North* and *South* Dial, as you see done in the Dials.

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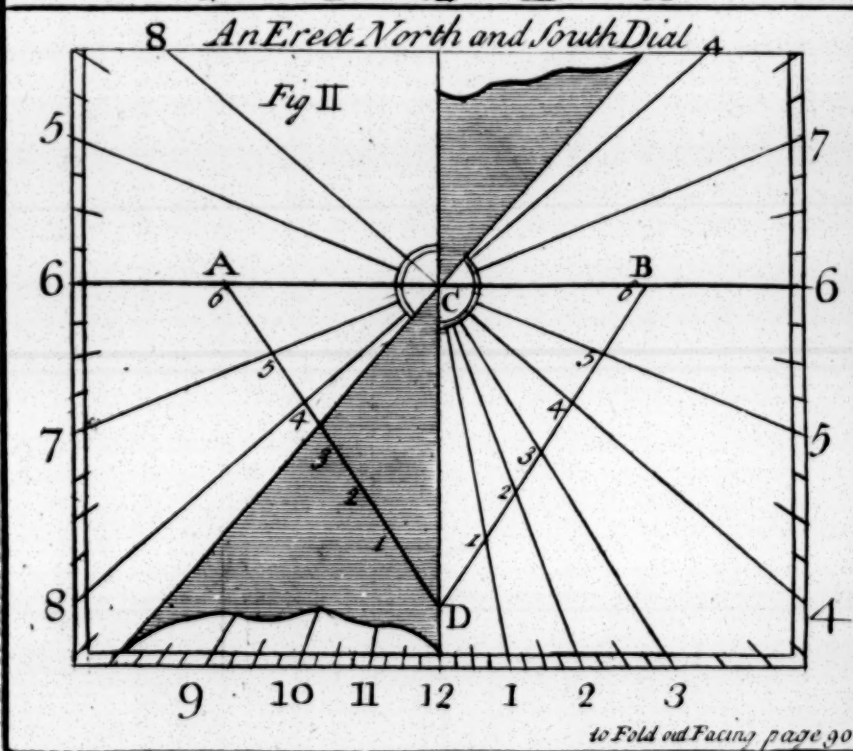
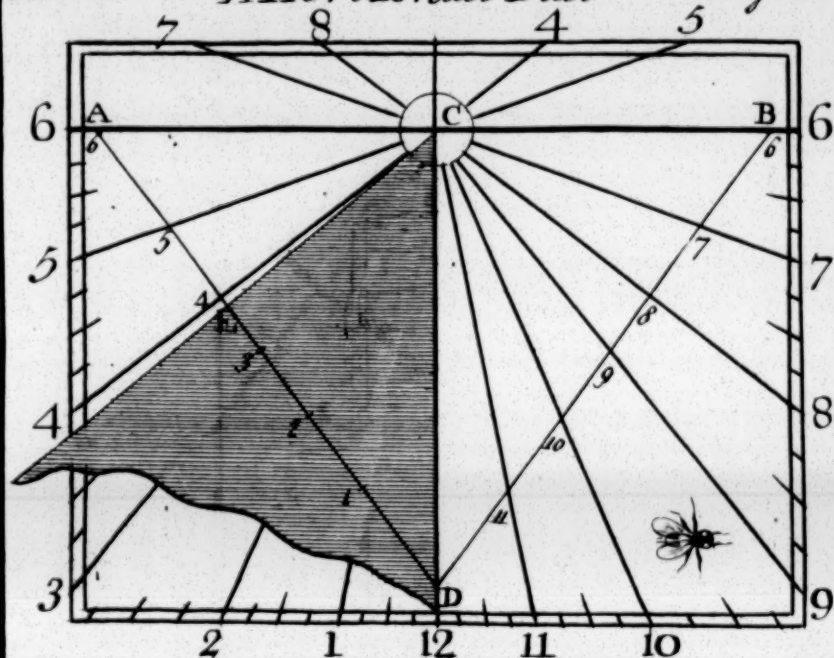
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*These Dials are made by Scales in Plate 2*

*Plate II*

*A Horizontal Dial*

*Fig I*



*to Fold out Facing page 90*





Ch. 2

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## Ch. XX. Of the Use of the Scales in Plate II. 91

By the *Scale of Inclinations* is known in *erect Decliners*, where the *substilar Line* will fall; which must always be on the *contrary Side* the *Meridian Line* or *Hour Line* of 12; that is, if the Plane declines *Westward* the *substilar Line* must stand on the *East side*, but if the Plane declines *Eastward*, then the *substilar Line* must be placed on the *West side* the *Meridian*: and if the *Inclination of Meridians* be *less* than 15 *Deg.* the *substilar Line* will fall *between* 11 and 12, or between 12 and 1 a-clock, according to which *Point of the Heavens* the Plane declines: if the *Inclination of Meridians* be more than 15 *Deg.* but less than 30, the *substilar Line* will fall between the Hours of *one* and *two*, &c. Some *Dialists* put the *Difference of Meridians* of *several Places*, as *Jerusalem, Madrid, &c.* upon the Dial, to shew the Time of the Day at *those* Places, as well as the Time *where you are*; but this is needless; for if at any Time you would know what a-clock it is at any Place in the known World, when it is such a Time at *London*, only turn to the Table of the *Latitude and Longitude* of Places at the End of this Treatise, and there see what the *Difference of Meridians* is; and if the Place be to the *East* of *London*, add the *Difference of Meridians in Time* to the Time at *London*, which gives the Time at *that* Place; but if it lie to the *West*, subtracting the *Difference of Meridians in Time* from the Time at *London*, gives you the Time of the Day at *that* Place.

### Example.

Suppose it is 10 a-clock in the *Forenoon* at *London*, what Time is it *then* at *Constantinople*, and alio at *Port-Royal* in *Jamaica*?

Given

|                                  |   |   |   |   |    |    |
|----------------------------------|---|---|---|---|----|----|
| Given Time at London is          | — | — | — | — | H. | M. |
| Constantinople to the East (add) | — | — | — | — | 10 | 00 |
|                                  |   |   |   |   | 1  | 59 |
| Time at Constantinople           | — | — | — |   | 11 | 59 |

That is 59 Min. *past* Eleven in the *Forenoon*.

*Again.*

|                                   |   |   |   |   |    |    |
|-----------------------------------|---|---|---|---|----|----|
| Given Time at London is           | — | — | — | — | H. | M. |
| Port Royal to the West (subtract) | — | — | — | — | 10 | 00 |
|                                   |   |   |   |   | 5  | 4  |
| Time at Port Royal in the Morning | — | — | — |   | 4  | 56 |

The like of any other Place in the *Catalogue*.

### *The Use of the* TRIGON.

*See the Figure on Page 10.*

You are to take notice, that the *Parallels of the Signs*, the *daily Arches*, the *Circles of Altitude*, and *all other Circles* relating to the *Course of the Sun*, when they are described upon any *Sun Dial*, are not shadowed out by the *whole Stile*, or *Axis of the Dial* as the *Hours* are, but by *some one Point* in the *same Stile* or *Axis*; as by a *Knob*, *Button* or *Notch*, filed in the *Stile* of the *Dial*; or by a *Hole in a Glass Window* for *projected Dials*; or by a *Piece of Looking Glass* for *reflected Dials*; in all which Cases the *Trigon* at C is to be applied, so that the *Line* thereof marked A B, must lie upon the *Stile* of the *Dial*, or *parallel* to the *Axis of the World*, if it be an *Hole in a Window*, or a *Piece of Looking-Glass*: And now, the *Trigon* being thus placed with the *Equinoctial* C D  $\perp$  *perpendicular to the Stile*, the *Center* being always fixed upon the *Button* or *Notch*, or *Knob*, so that you may turn it about the *Axis*, as occasion shall require.

*For,*



*For the Equinoctial.*

Now suppose you would insert the *Equinoctial* into any Dial, (for *one Rule serves for all Planes.*) First, put a *Thread* through the *little Hole* marked with ● at  $\gamma$  and  $\alpha$ , tying a *Knot* on the *Thread* that it slips not through the *Hole* in the *Trigon*; then put the *Center C* to the *Knob* in the *Stile*, and the *Side AB* to the *Stile* itself: This done, extend the *Thread* over the *Line CD*  $\gamma$  till it touches the *Dial Plane*; that *Point of touching* shall be *one Point* through which the *Equinoctial* is to be drawn upon the *Plane*: Then turning the *Trigon* about, still keeping the *Line AB* parallel to the *Stile*, extend the *Thread* till it touch the *Dial Plane* in some *other Point*, and that shall be *another Point*, through which the *Equinoctial* is to be drawn upon the *Dial*.

And if your *Dial* be all but *one plain Superficies*, *two Points* will be sufficient to draw the *Equinoctial* by, it being a *great Circle* of the *Sphere*, and consequently a *right Line* upon all *plain Superficies*, But,

If the *Dial* consist of *more than one Plane*, then must you, in the same manner as before, find *two Points at least* upon *each Superficies*; which you may easily and speedily do by turning the *Trigon* about the *Stile*, and keeping the *Side AB* parallel thereto, extending the *Thread* over the *Line CD*  $\gamma$  till it touch the *Plane*.

*For the Tropick of Cancer.*

In like manner if you would insert the *Tropick of Cancer* into your *Dial*, you must put the *Thread* in the *Hole* at  $\delta$ , and then apply the *Center C* to the  
*Knob*

94      *Of the Use of the Trigon. Chap.XX.*

*Knob* in the *Stile*, keeping the Side *A B* parallel to the *Stile* (as before) extend the Thread over the Line *C*  $\infty$  till it touch the Plane, and that Point of touch must be *one Point* through which the *Tropick* of *Cancer* must pass.

Again move the *Trigon* in the *same Position* upon the *Stile of the Dial* as occasion requires; extend the Thread over the *Tropick* *C*  $\infty$  till it touch the Plane, and that shall be *another Point* through which the *Tropick* must be drawn, and in this manner you may find as many Points upon the Plane as you please, and *the more the better*, for *these Parallels* will not be *streight Lines*, as the *Equinoctial Line* was, but *conic or curved Lines*, through which Points a Line being traced, with an *even hand*, shall be the *Tropick of Cancer* upon your *Dial Plane*.

*For the Tropick of Capricorn.*

And in this manner may the *Tropick of Capricorn*, and all the *Parallels* of the *other Signs* (or any other *Parallel* of the *Sun's Declination*) be drawn on your *Dials*, if first you put the *Thread* through the *respective Hole*, and apply the *Trigon* to the *Stile*, and extend the Thread over the *Parallel of Declination* till it touch the Plane; and thus you may find as many Points as you please, thro' which to draw your *Parallels*; and this may suffice for the *Inscription* of the *Parallels* of the *Signs of the Zodiack*.

And if you would insert the *Parallels* for the *length of the Day*, they are to be done in the same manner, if instead of the *Declinations for the Signs*, you put into your *Trigon* the *Parallels* for the *length of the Days* you intend to insert into your *Dial*.

N. B. In Page 90 I have given a caution to all *Dialists*, that they be careful *always* to make *Allowance* for the *Thicknes* of the *Stile*, otherwise the *Dial* will err from the *Truth*.

C H A P.

CHAP. XXI. *A Review of the Equinoctial and Direct East and West Dials.*

*Of the Equinoctial Dial, after what is said concerning it in*  
CHAP. III.

**I**F to this you add a *Semicircle* to represent *one half* of the *Meridian*, and graduate the *Meridian* unto 180 Deg. by two Ninety's, and set it in a Notch over a Box and Needle well touched with the Loadstone, it will shew you the Hour of the Day wherever you be, as also the *Variation* of the Needle itself in that Place; for when you have set it to shew the *Hour*, if the *Needle* then lies *parallel* with the *Semicircle*, representing *one half* of the *Meridian*, it has then no *Variation*, but if it lies athwart with the *Meridian*, the *Angle* that it makes either to the *East* or *West* is the *Variation* of the Needle in that Place.

N. B. It matters not whether you put any more *Hour Lines* upon the Dial than are *useful in the Latitude where you are*; as for instance, at *London* you may omit the Hours *after eight at Night till four in the Morning*.

How naturally the *Hour Lines* may be drawn upon any Plane from the *Equinoctial Dial*, I shall here shew. Fix your *Stile* to your Dial Plane *in its right Position* by help of your *Quadrant*, *i. e.* by applying the Edge thereof to the *Stile*, and then the String cutting the Limb thereof in the Degrees of the *Latitude* of your Plane, because the *Top* of the *Stile* is *parallel* to the *Earth's Axis*; and be careful also that it stands at *right Angles* to the *substilar Line*, whatever Dial it be; then cut a Slit quite thro' the *Equinoctial Dial* from the *North edge* to the *Center* along the 12 a-clock Line, just so wide as to receive  
your



your Stile; put this Slit upon the Stile of your Dial, so that the *Equinoctial Dial* may stand at *right Angles* thereto, for then doth it lie parallel to the Plane of the *Equinoctial* itself: From that Point where the *Equinoctial Dial* toucheth the Stile, let fall a Perpendicular upon the *substilar Line*, this I call the *perpendicular height* of the Stile; take this in your Compasses, and set one Foot in the *substilar Line* where the *perpendicular height* of the Stile touched it, and sweep a *Circle*; to this Circle draw a *tangent Line* at *right Angles* to the *substilar Line*; Lastly, Put a Thread in the Center of the *Equinoctial Dial* (allowing for the Thickness of the Stile) and stretch it over the *Hour Lines*, and where the Thread toucheth the *Tangent Line* upon your Plane make Marks; and Lines drawn from the Center of your Dial to those Marks in the *Tangent Line* are the true *Hour Lines* upon your Dial: and this is a plain and ready way of drawing *Hour Lines* upon all Sorts of Planes.

*A Review of the direct West Dial,*

*After what is said concerning it in Chap. VII. VIII.*

This Dial as well as the *East Dial* is universal, which I thus explain; procure a Plate of Brasse of what Size you please, and about the Thickness of a Shilling, well polished on both Sides, on which draw an *East Dial* on *one Side* and a *West Dial* on the *other*, so that the Center of the Circle PHDS, on *one Side* may exactly answer the Center of the Circle on the *other Side*; let a Circle circumscribe your *Dials*, and the upper Quadrant divided into 90 equal Parts or *Degrees*; let there be a Ring in a swivel to screw to the *Zenith* of the Place wherever you be, after the manner of a *Ring Dial*; then hanging it on your Finger, placing its Plane parallel to the Meridian of  
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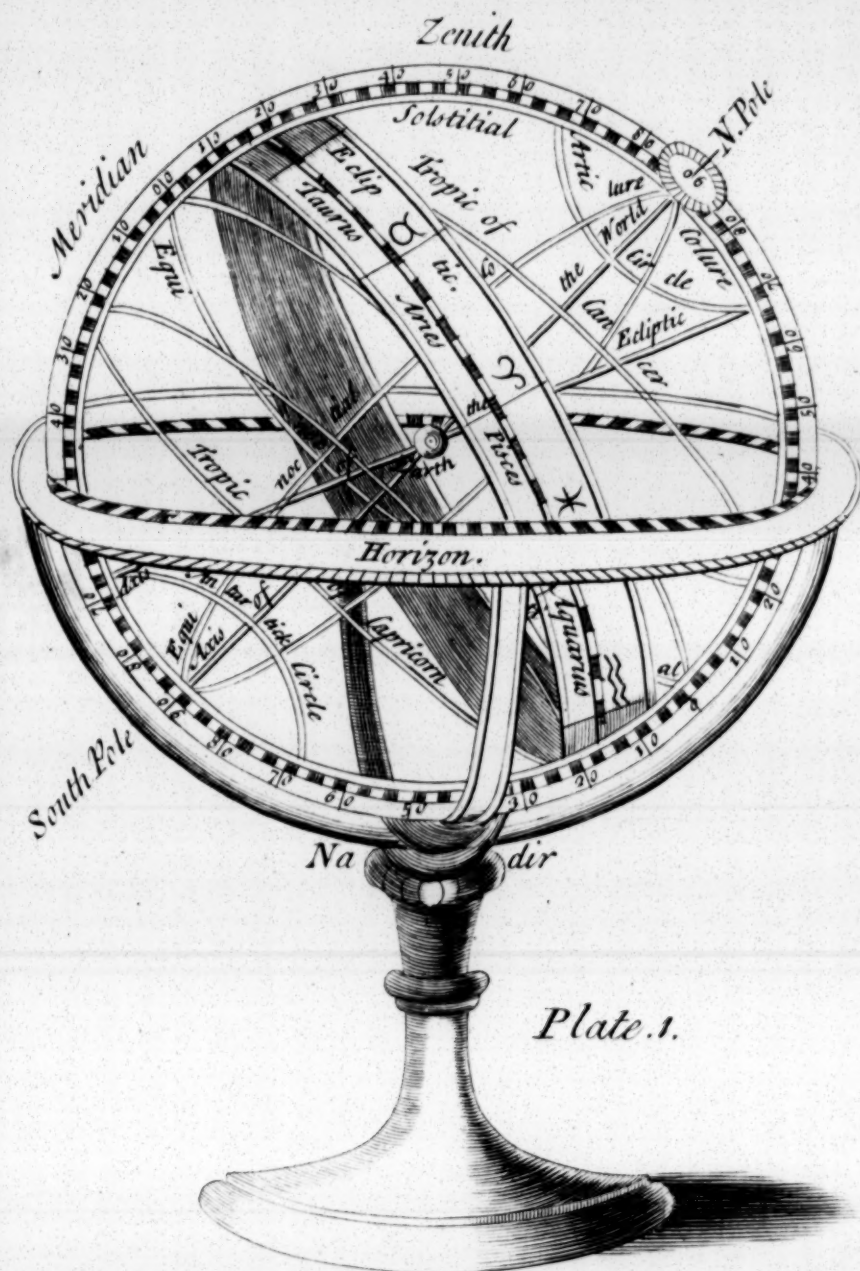


Plate 1.

The Sphere

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## Ch. XXII. *A Description of the Sphere.* 97

the Place (which may be done by help of a Magnetic Needle) it will shew you the true Hour of the Day, except it be exactly 12 a-clock, and then neither the *East* or *West* Side will shew the Hour, for the Shadow of the Stiles do then fall off both the Planes.

These Things I mention as Curiosities, shewing how by keeping the Axis of your Dial parallel with the Axis of the World, the Dial by that means is universal, for under the *Arctic Pole* the Hour Line will be *perpendicular* to the Horizon, and under the *Equinoctial* they will become *parallel*, or lie in the Plane of that great Circle. But if under the *Equinoctial* you lay the Dial flat down, so that the Circle PHDS may represent the Horizon of that Place, and placing 12 where 6 now stands, one where 5 is, &c. and 11 where 7 is, and 10 instead of 8. &c. to 6; this Dial will then represent a *Polar* or *Equinoctial* Dial, which ever you please to call it.

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## CHAP. XXII. A DESCRIPTION of the SPHERE. (See the Print.)

THERE are *Ten* eminent *Circles* upon the Sphere; *Six* of which are called *greater Circles*, and the other *Four* are called *lesser Circles*.

A *great Circle* of the *Sphere* is that whose *Plane* passeth through the *Center* of the *Sphere*, and divides the *Sphere* itself into *two equal Parts*.

A *lesser Circle* is that which lies *parallel* to a *greater*, as the *Tropicks* or *Polar Circles* do to the *Equinoctial*.

Or *lesser Circles* are such as do *not* divide the *Sphere* into *two equal Parts*.

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The



98 *A Description of the Sphere.* Chap. XXII.

The six greater Circles are the *Horizon*, the *Meridian*, the *Equinoctial*, the *Ecliptick*, the *Equinoctial Colure*, and the *Solstitial Colure*, and the four lesser Circles are the *Tropick of Cancer*, the *Tropick of Capricorn*, and the two *Polar Circles*. But,

First, Of the Six great Circles.

1. The *Horizon* is that Circle whereon the *Earth* and *Sky* seem to meet, and therefore when the *Sun*, *Moon*, and *Stars* come to the *East* thereof they are said to *rise*, and when they come to the *West* thereof they are said to *set*.

2. The *Meridian* is that Circle which is exactly in the middle between the *East* and *West*, and always cuts the true *North* and *South* Points of the *Horizon*; its Use is to shew the Time of *Mid-day* and *Mid-night*; for when the *Sun* comes to the *South Point* of this Circle which is above the *Horizon*, it is *Noon*; and when to that Point of the Circle which is under the *Horizon*, then it is *Midnight*; and that Point in the *Meridian* which is exactly over your *Head*, is called the *Zenith*; and that under your *Feet* the *Nadir*.

3. The *Equinoctial* Circle is always distant from you as much as is the *Latitude of the Place* you are in, and is also equal to the *Height of the Pole* above your *Horizon*; its Use is to determine the Time of the *Day* or *Night*; for every 15 Deg. thereof is equal to one Hour in Time, and it always cuts the true *East* and *West* Points of the *Horizon*.

4. The *Ecliptick* is that Circle in which the *Sun* is said to move, and this Circle cuts the *Equinoctial* in the beginning of *Aries* and *Libra*, making an Angle therewith of 23 Deg. 29 Min. which Angle is equal to the *Sun's greatest Declination*: It is divided into  
twelve

## Chap. XXII. *A Description of the Sphere.* 99

*twelve* equal Parts, called *Signs*, and *charactered* as in the *Figure* with  $\gamma$ ,  $\delta$ ,  $\eta$ , &c. and every *Sign* is divided into *thirty* equal Parts called *Degrees*; so that

*This*, and every great Circle of the Sphere contains 360 *Degrees*.

N. B. In or near this Circle the *Eclipse* of the *Sun* and *Moon* are always found, from whence it takes its Name.

5. The *Equinoctial Colure* is a Circle that cuts the *Equinoctial* at *right Angles* in the *beginning* of *Aries* and *Libra*, and passes thro' the *Poles* of the World: This Circle determines the *beginning* of the *Spring*, and *fall of the Leaf*; for when the *Sun* comes here (which is on the 21<sup>st</sup> of *March*, and 22<sup>d</sup> of *September*) the *Days* and *Nights* are equal.

6. The *Solstitial Colure* is a Circle that cuts the *Equinoctial Colure* at *right Angles* in the *Poles* of the World, and when *Cancer* is upon the *Meridian*, this Circle is also upon the *Meridian* (as you may see by the Sphere) when the *Sun* comes to this *Colure* (which is upon the 21<sup>st</sup> of *June* and the 22<sup>d</sup> of *December*) he determines the *longest* and *shortest Days* to all the *Inhabitants* on the *North Side* the *Equinoctial*.

N. B. The above *six Circles* cut the *World* into *two* equal Parts.

Secondly, *Of the FOUR lesser Circles of the Sphere.*

1. The *Tropick of Cancer* is parallel to the *Equinoctial*, and distant from it 23 Deg. 29 Min. which is the *Sun's greatest Declination Northward*; here the *Ecliptick* and the *Solstitial Colure* meet in the very beginning of *Cancer*, making the *longest Day* to all the *Northern Inhabitants*.

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2. The *Tropick of Capricorn* is also parallel to the *Equinoctial*, but distant from it 23 Deg. 29 Min. towards the *South*, and is equal to the *Sun's greatest Declination*; here the *Ecliptick* and *Solstitial Colure* meet in the very beginning of the Sign *Capricorn*, making the *shortest Day* to all the *Northern Inhabitants*.

The Reason why these are called *lesser Circles* is, because they cut the *Sphere* (or *World*) into *two unequal Parts*.

LASTLY, The *two Polar Circles* are the same Distance from the *Poles*, that the *Tropicks* are from the *Equinoctial*, viz. 23 Deg. 29 Min. When the *Sun* enters *Cancer*, those that live under the *Arctic Circle* see him in their *Horizon* at *Midnight*, and when the *Sun* enters *Capricorn*, those that live under the *Antarctic Circle* see the *Sun* in their *Horizon* at *Midnight*.

The *Earth's Axis* is a Line supposed to pass from *Pole to Pole*, and through the *Earth's Center*; and note, it always represents the *Top*, or uppermost Part of the *Stile* in all *Dials*: and makes an *Angle* with the *Horizon* equal to the *Latitude* of your *Habitation*: and it always cuts the *Equinoctial* at *right Angles*, and the *Equinoctial* makes an *Angle* with the *Horizon* equal to the *Complement of the Latitude of the Place* where you live.

The *Earth* is fixed upon its *Axis* in the *middle* of the *Sphere* (or *World*) and in *Dialling* it is reckoned no more than a *Point*, because it is at so vast a Distance from the *Sun*.

N. B. The *Axis* of the *Ecliptick* is noted in the *Sphere*, but is of no manner of Use in *Dialling*.

CHAP.



CH A P. XXIII. Motto's for Dials, with  
their Meaning in English.

- 1 { *ALII S* *inerviando* *consumor*.  
Profit by my Loss.
- 2 *Ars longa, Vita* Art is without End,  
*brevis.* Life but a Span.
- 3 { *Avaritia hodie dominatur.*  
You covet to-morrow.
- 4 *Aut Caesar aut nihil.* I shine or shroud.
- 5 \*About your Business.
- 6 *Amat Lucem.* It loves the Light.
- 7 *Adveniet ille Dies.* The Day will come.
- 8 { *Abi, non moratur Hora, ambula in Luce.*  
Begone, the Hour flies, walk in Light.
- 9 *Alias et idem.* Every where the same.
- 10 *Aspice fugimus.* Behold we fly.
- 11 { *A [or e] Cœlo Veritas*  
Truth the Daughter of Heaven.
- 12 *Agi ad pœnitendum.* Forced to recant.
- 13 *Bulla est vita humana.* Life's a Bubble.
- 14 *Brevis Hominum vita.* Short is human Life.
- 15 Behold and be gone about your Business.
- 16 Consume not thy Time in Idleness.
- 17 *Cursum peregi.* I have finished my Course.
- 18 *Circumspicit omnia.* He beholds all Things.
- 19 { *Claritatem et splendorem solis indico.*  
I shew by the Kindness and Splendor of the Sun.
- 20 { *Cum tempus non existit, tunc morior.*  
When Time ceases to exist, I shall be forgotten.

\* On the General Post Office.

102 Motto's for *Dials*, &c. Chap. XXIII.

- 21 { *Certitudinem acquirit eundo.*  
 Its Progress confirms its Certainty.
- 22 *Carpe diem.* This is the Day.
- 23 { *Carpe diem quam minimum credula postero.*  
 None can tell what will happen to-morrow.
- 24 { *Cui solem anteferam?*  
 What can be compared with the Sun?
- 25 *Cito pede labitur atas.* Time passes swiftly away.
- 26 *Cito pede praterit atas.* Time swiftly flies away.
- 27 *Concito gradu.* My Flight is rapid.
- 28 *Considera te.* Know thyself.
- 29 *Certa Ratio.* An account must be given.
- 30 *Cedimur merito.* We suffer deservedly.
- 31 { *Deus adest laborantibus.*  
 Heaven favours the Diligent.
- 32 { *Disce dies numerare tuos.*  
 Learn to value your Time.
- 33 { *Disce bene vivere & mori.*  
 I live and die happy.
- 34 *Dies diem trudit.* A Day may ruin thee.
- 35 *Dum spectas fugio.* I fly while you behold me.
- 36 { *Dona presentis cape latus.*  
 Enjoy the present Hour.
- 37 { *Discite justitiam moriti.\**  
 I earn to be wise in Time.
- 38 { *Dum spectas fugit hora.*  
 The Hour flies while you are gazing.
- 39 *Dum fugio numeras.* I fly while you number.
- 40 *Disce mori mundo.* Die to the World.
- 41 { *Dum fugit umbra, quiesco.*  
 The Shadow moves tho' I am at Rest.
- 42 { *Durabit splendor solis.*  
 The Light of the Sun shall endure.

43 *Dona*

\* At Westminster-Hall.

- 43 { *Dona presentis rape latus.*  
 Chearfully accept of Things present.  
 44 *Depressa resurgo.* I set to rise.  
*Dare quam accipere.*  
 45 It is more blessed to give than to receive.  
 46 { *Dum videam satis est.*  
 If I but see it is sufficient.  
 47 { *Dum spectas splendit.*  
 Whilst thou art looking he shines.  
 48 *Disponit tempus dies.* Days make Years.  
 49 { *Dies affert multa.*  
 Sufficient to the Day is the Evil thereof.  
 50 { *Disce tuos numerare dies.*  
 Learn to number thy Days.  
 51 { *\*En supra vita fugax.*  
 † *En infra certa mors.*  
 A Life on Flight's soon out of Sight.  
 52 { *Ex hoc momento pendet aternitas.*  
 On the present Moment depends Eternity.  
 53 { *Eheu fugaces labuntur anni!*  
 Where is last Year flown!  
 54 { *Ecce ut hora sic fugit vita.*  
 Life flies like the Hour.  
 55 *Ecce hora.* Now or never.  
 56 *Et nobis et vobis.* To us and you.  
 57 { *Eternum tibi semper adesse puta.*  
 You are on the Brink of Eternity.  
 58 { *Ecce nunc tempus acceptabile festine salvare.*  
 Now is the accepted Time, now is the Day of Salvation.  
 59 { *\*\*Edwardus fovet ut sol.*  
 Edward beneficent as the Sun.

\* At the Top { of one Face of a Dial on St. Mary Overy's Church,  
 † At the Bottom { Southwark, which hangs over the Burial Ground.  
 \*\* On Christ's Hospital, founded by EDWARD the Vth.





Chap. XXIII. Motto's for *Dials*, &c. 105

- 80 *Hora pars vitæ.* Every Hour shortens life.
- 81 } *Horam quam petis redimite.*  
Redem the Time.
- 82 } *Haud mora carpe diem.*  
Seize the present Opportunity.
- 83 *Hoc tuum est.* The present only is thine.
- 84 *Heu! quærimus umbram.* We pursue Shadows.
- 85 *Hora vitam imminuit.* Every hour shortens life.
- 86 *Hoc age.* Remember.
- 87 *Hodie mihi cras tibi.* Each in his Turn.
- 88 *Ita vita.* Such is Life.
- 89 I bide my Time. I stay for no Man.
- 90 *Immo um in motu.* Ever the same.
- 91 } *Inter Cæsarem & Galbam*  
*Sol ministrat umbram.*  
The Sun is alike beneficent to all.
- 92 } *Interpres fidus solis.*  
I interpret faithfully the Sun.
- 93 *Indico utere.* Improve by my admonition.
- 94 *In singulas horas.* Every Moment.
- 95 *Ingravantibus annis.* Our Years multiply.
- 96 *Labor ipse voluptas.* I labour for your Pleasure.
- 97 } *Lex Dei lux Dei.*  
The Law of God is as clear as the Light.
- 98 Let your Light so shine that Men may see your good Works.
- 99 } *Lente suscipe cito perfice.*  
Set out at Leisure, proceed with Haste.
- 100 *Luci laborandum.* Walk whilst it is light.
- 101 *Luce lucit.* He shines in the Light.
- 102 *Lux post umbram.* After Darkness Light.
- 103 *Lux venit ab alto.* Light comes from above.
- 104 } *Leges luce clariores*  
Thy Commandments enlighten the Eyes.
- [104] *Luceo et lateo.* I shine and set.

106 Motto's for *Dials, &c.* Chap. XXIII.

- 105 *Lux umbra Dei.* { God is Light.  
Light is God's Shadow.
- 106 Look forward.
- 107 *Ludimus leve.* We trifle.
- 108 *Lues culpam spiritu.* Your Life shall pay for it.  
{ *Mora trahit periculum.*
- 109 { Delay is the Parent of Danger.  
{ *Me ortum vides forsan non occasum.*
- 110 { You have seen me rise, but may not see me set.
- 111 *Maneo nemini.* I stay for no Man.  
{ *Memor esto brevis ævi.*
- 112 { Remember the Shortness of Life.
- 113 Mind your Business.
- 114 *Monstrat in silentio.* Silent Instruction.
- 115 *Mors ultima pœna est.* Death closes the Scene.
- 116 *Mors omnia vincit.* Death conquers all.  
{ *Mors de die accelerat.*
- 117 { Every Day brings Death nearer.
- 118 { *Mors nobis quotidie imminet.*  
{ This Day may be your last.
- 119 { *Memor esto quod morieris?*  
{ Can you forget you are mortal?
- 120 *Mors meta laborum.* Death terminates Labour.
- 121 *Mors iter ad vitam.* To die is to live.
- 122 *Moriendo vivo.* I live and die daily.
- 123 *Metam properamus ad unam.* All must die.
- 124 *Mortalia cogita.* Remember thou art mortal.  
{ *Me lumen vos umbra regit.*
- 125 { Light directs me, and you a Shadow.
- 126 *Mors omnia sternit.* Death conquers all.
- 127 *Me nutrit Apollo.* Apollo is my Teacher.  
{ *\*Mentiri non est meum.*
- 128 { Lying does not belong to me.

\* On a Dial facing *Billingsgate*, where the Dealers in Coals assemble daily.



- 129 Man's but a Shadow.
- 130 { *Nemo sine crimine vivit.*  
The brightest Day has its Shades.
- 131 { *Nil dat quod non habet.*  
Of nothing, nothing can be produced.
- 132 { *Non semper erunt Saturnalia.*  
Take Time by the Forelock.
- 133 { *Non nobis nati sumus.*  
We are not made for our selves.
- 134 *Non sine lumine.* Not without Light.
- 135 *Nosce teipsum.* Know thyself.
- 136 *Nulla dies sine linea.* Improve every Day.
- 137 { *Noli confidere noctem.*  
You are not sure of seeing Night.
- 138 { *Non progredi et regredi.*  
Every Stop lessens the Progress.
- 139 { *Nos flendo ducimus horas.*  
Life is a melancholy Tale.
- 140 *Nascimur & morimur.* Born and dead.
- 141 *Non moror.* I never stop.
- 142 *Non redibo.* Never to return.
- 143 { *Nec sol in summo manet.*  
The Sun has his Vicissitudes.
- 144 { *Nil boni hodie diem perdidit.*  
What good actions have you performed to-day
- 145 *Nec metuenda viris.* Indifferent to the Wife.
- 146 { *Neque lux sine umbra.*  
No Light without a Shadow.
- 147 *Nocet umbra nocenti.*
- 148 *Non semper clarum.* Not always intelligible.
- 149 *Nos ut umbra.* We resemble the Shadow.
- 150 *Nescitis horam.* Ye know not the Hour.
- 151 *Non vetuit mori.* No flying from Death.
- 152 *Nostra latet.* We know not our End.

108      *Motto's for Dials, &c.* Chap.XXIII.

- 153 { *Non memet extinguo.*  
My Term is not my own Decree.
- 154 { *Non quantum, sed quo modo.*  
The Manner, not the Matter.
- 155 { *Non aliter perio species quam futilis umbra.*  
My Emblem is a Shadow.
- 156 *Nihil velocius annis.* Nothing fleetier than Time.
- 157 *Non in tenebris.* Not in Darkness.
- 158 *Non regonisi regar.* As I am directed I direct.
- 159 { *Noli imputare mihi.*  
Place them not to my Account.
- 160 *Nocendum nulli.* Injure no Man.
- 161 *Noli irascaris.* Avoid Anger.
- 162 { *Omnem crede diem tibi diluxisse supremum.*  
Believe every Day to be the last.
- 163 { *Omnia falce metit tempus.*  
Nothing can resist the Scythe of Time.
- 164 *Orimur et morimur.* We rise and set.
- 165 { *Omnia fallace que mentres appressa fuge!*  
Delusive Shadow, so speedy in thy Flight!
- 166 *Otium fuge.* Fly Idleness.
- 167 { *Omnia fert etas.*  
Time brings all Things to pass.
- 168 { *\*Oriens sol adornatur.*  
When Sol adorns the East.  
All worship the rising Sun.
- 169 { *Pereunt et imputantur.*  
The Hours vanish, yet are recorded.
- 170 *Pax optima rerum.* Light is the Parent of Peace;
- 171 { *Post voluptatem misericordia.*  
Pleasure is the Parent of Pain.  
Night treads upon the Heels of Day.

\* An East Dial.

† Upon a Dial at a Lock, or Hospital for those who have the  
foul Disease.

- 172 Peace, Love and Unity, through Time to Eternity.  
 173 Prize Time.  
 174 { *Pulvis et umbra sumus.*  
 { Life passes like the Shadow.  
 175 *Proba veritatem mei.* Try me.  
 176 { *Publica privatis secernite sacra prophanis,*  
 { Be always discrete.  
 { *Plura labori dulcibus quædam otijs.*  
 177 { Repose after Labour is sweet.  
 178 *Post tenebras lucem.* After Darknes Light.  
 { *Post tenebras spero lucem.*  
 179 { After Darknes I hope for Light.  
 { *Præstant æterna caducis.*  
 180 { Eternity alone merits our Attention.  
 { *Procrastinatio est odiosa.*  
 181 { Delays are dangerous.  
 { *Post est occasio calva.*  
 182 { Do not omit the present Opportunity.  
 { *Phœbus instar revivisco.*  
 183 { I revive like the Sun.  
 184 *Phœbus recreat quæ vulcanus excussit.*  
 { *Proxima non nostra est.*  
 185 { The next is not in our Power.  
 { *Qualis vita, finis ita.*  
 186 { A virtuous Life, a happy Eternity.  
 187 { *Quod tibi fieri non vis, alteri ne feceris.*  
 { Do as you would willingly be done by.  
 { *Qua redit nescitis horam.*  
 188 { Ye know not the Hour.  
 { *Quid celerius tempore?*  
 189 { What is swifter than Time?  
 { *Quam quæras ne perdas*  
 190 { Secure it whilst in your Power.



110 *Motto's for Dials, &c. Chap. XXIII.*

- 191 { *Quid cunctaris nisi occupas fugit.*  
 { Seize the flying Hour.
- 192 { *Quod petis umbra est.*  
 { You pursue a Shadow.
- 193 { *Quod vides non diu.*  
 { The Things seen are temporal.
- 194 *Qua pote lucet.* Exert your Talents.
- 195 { *Quid optas quod habes.*  
 { Ridiculous! to wish and have.
- 196 { *Quasi umbra transit vita*  
 { Life passes like the Shadow.
- 197 { *\*Quid stans? transit est hora*  
 { All is temporary, and passeth like the Hour.
- 198 *Quid multa?* One Thing is necessary.
- 199 *Quanta res!* How important!
- 200 *Redime tempus.* Redeem the Time.
- 201 { *Redime tempus, nil perpetuum*  
 { Redeem the Time, it will soon be gone;
- 202 { *Redime tempus, vivitur ex raptō.*  
 { Redeem the Time, the Tenure is uncertain.
- 203 *Revocabile tempus.* Recall the Time.
- 204 *Resurga.* Awake to Life.
- 205 † *Resurgam.* I shall rise again.
- 206 *Ruit hora.* The Hour flies.
- 207 Remember.
- 208 *Rus in urbe.* The Country in the City.
- 209 *Religionem cole.* Honour Religion.
- 210 *Sic vita* Such is Life.
- 211 { *Sic transit gloria mundi*  
 { So marches the God of Day
- 212 *Sine lumine inane.* Not without Light.
- 213 *Sic præterit ætas.* Life flies swiftly.

\* On the Church Porch of Calbeck in Cumberland.

† Alluding to the setting Sun.

Chap. XXIII. Motto's for Dials, &c. 111

- 214 *Sic hominis vita.* Such is the Life of Man.  
 215 *Semper in motu.* Ever in Motion.  
 216 { *\*Sol lucet charitas extenait omnibus.*  
 { Charity, like the Sun, is beneficent to all.  
 217 So flies Life away.  
 218 *Sensim sine sensu.* { Insensibly  
 { I move insensibly.  
 219 *Senescimus effugit etas.* Old Age approacheth.  
 220 *Semper paratum.* Be always prepared.  
 221 *Subserviens vehicula lucis.*  
 222 { *Sic tibi tempus erit.*  
 { Your Time is approaching.  
 223 { *Suprema hæc multis forsân tibi.*  
 { The last to many, possibly to you.  
 224 { *Suprema multis hora forsân tibi.*  
 { The last Hour to many, possibly to you.  
 225 † *Sicut flos.* Like a Flower.  
 226 { *Sol ministrat umbram.*  
 { The Sun causes the Shadow  
 227 || *Sumus fumus* We vanish like Smoke.  
 228 So flies Life away.  
 229 { *Sol gloria spheræ*  
 { The Sun gives a Lustre to the Universe.  
 230 { *Sic siti letamur lares!*  
 { How delightful the extended Prospect!  
 231 { *Sic imus ad atria lucis,*  
 { *Aut umbras erebi.*  
 { Thus we pass on to Happiness or Misery.  
 232 *Sic subducimur.* Thus our Lives terminate.  
 233 { *Sol splendit omnibus.*  
 { The Sun shines on all.

\* At a Charity School.

† In a Garden.

|| On a Chimney.

112 Motto's for Dials, &c. Chap. XXIII.

- [233] { *Si Deus nobiscum quis contra nos.*  
My God and all Things.
- 234 { *Salve domine Anglorum.*  
Hail Lord of Britain.
- 235 { *Spectator fastidiosus sibi molestus.*  
Envious Spectator, be thy own Tormentor.
- 236 *Semel elapsum.* Once elapsed.
- 237 { *Tempus ad lucem ducit veritatem.*  
Time brings Truth to Light.
- 238 { *Tempus obit, mors venit.*  
Time dies, Death reigns.
- 239 *Tempus fugit.* Time flies.
- 240 { *Tempus vitæ monitor*  
Time is a Memento to Life.
- 241 { *Tenere non potes nec perdere.*  
Impossible to be kept or lost
- 242 { *Tempus me velocius avolans redimite.*  
The Rapidity of Time augments its Value.
- 243 { *Transit hora sine mora.*  
Tis impossible to stop the fleeting Hour.
- 244 { *Tempus rerum imperator*  
Time commands all Things.
- 245 *Tempus labitur* Time steals away.
- 246 *Tarde sed certe* Slow but sure.
- 247 Take Time by the Forelock.
- 248 Time flies
- 249 { *Tempus edax rerum*  
Time brings all Things to an End.
- 250 { *Tenere non potes, non perdere potes.*  
You may waste, but cannot stop me.
- 251 True as the Dial to the Sun
- 252 \**Tanquam fumus.* { Like Smoke.  
Life vanishes like Smoke.

\* On a Chimney.

253 *Tempori*



Chap. XXIII. Motto's for Dials, &c. 113

- 253 *Tempori pare.* Yield to the Times.  
 254 { *Tempus celerrime aufugit.*  
 { Time passes swiftly away.  
 255 { *Tempus omnia revelat.*  
 { Time reveals all Things.  
 256 { *Tempore fiunt omnia.*  
 { Time finishes all Things.  
 257 { *Tempus vitæ monitor.*  
 { Time is the Monitor of Life.  
 258 *Tempus breve est.* Life is short.  
 259 Take up the Cross and follow me.\*  
 260 Time and Tide stay for no Man.†  
 261 Time is precious.  
 262 { *Tempus fugit, mors venit.*  
 { Time's on the Wing, and Death's approaching.  
 263 { *Tot horæ quot vices.*  
 { Every Hour has its Changes.  
 264 *Truditur dies die.\*\** One Day succeeds another.  
 265 { *Tempora mutantur & nos.*  
 { All Things fluctuate.  
 266 *Trepide.* In a Hurry.  
 267 { *Umbra Dei.*  
 { The Workmanship of the great Architect.  
 268 { *Ut umbra sic vita.*  
 { Life is fleeting as the Shadow.  
 269 *Venio ut fur.* I steal imperceptibly upon you.  
 270 { *Vigilate & orate, tempus fugit.*  
 { Watch and pray, Time steals away.  
 271 *Via vitæ.* Life's Road.  
 272 { *Vita nostra est instar comædiæ.*  
 { Life often changes Scenes.

\* On the Face of a Dial, on which is painted St. Andrew and his Cross, on the South Side of St. Andrew's Church, in Holborn.

† At the Steel-Yard, facing the Thames.

\*\* HORACE.

114 Motto's for *Dials*, &c. Chap. XXIII.

- 273 { *Veritas temporis filia.*  
Time is the Father of Truth.
- 274 { *Vehimur properantibus horis*  
*ad cœlum aut erebum.*  
The fleeting Hours waft us to Happiness or Misery.
- 275 *Vigilate.* Be vigilant.
- 276 *Vestra latet.* Your Fate is uncertain.
- 277 { *Vanescit & iterum apparet.*  
It vanishes and appears.
- 278 *Verum soli.* True to the Sun.
- 279 { *Umbra videt umbram, vive hodie!*  
One Shadow gazeth at another.
- 280 { *Una dabit quod negat altera.*  
What is denied by one may be supplied by another.
- 281 { *Vigor ætatis fluit ut flos veris.*  
Life in its greatest Vigour is altogether Vanity.
- 282 { *Uttere præfenti, memor ultimæ.*  
If you remember the last, you'll improve the present.
- 283 { *Umbra transitus est tempus nostrum.*  
Our Life resembles the Shadow that passeth away.
- 284 { *Vive memor quam sis ævi brevis.*  
Life how short! Eternity how long!
- 285 { *Ventus quo vult spirat.\**  
The Wind bloweth where it listeth.
- 286 *Vita transit.* Life passeth away.
- 287 { *Verus sum temporis index.*  
I shew the Time faithfully.
- 288 { *Vivite, ait fugio.†*  
Live, it says, I am on the Wing.
- 289 *Volucris cursu.* With winged Speed.
- 290 Welcome Chapmen.\*\*

\* On a Wind Dial.

† B. Atterbury, at Bromley in Kent.

\*\* On a Dial in a Market Place.

Chap. XXIII. Motto's for Dials, &c. 115

291 Work to-day, and play to-morrow.

292 Watch, for you know not the Hour.

293 Watch.

294 Ζωὴ ἀτμὴ σκίνη. Life's the Spectator of a Shadow.

*Upon the Sun-Dial on the High-Church Wall of  
GLASGOW.* 295

Our Life's a flying Shadow, God's the Pole;  
The Index pointing at him is our Soul;  
Death's the Horizon, when our Sun is set,  
Which will through *Christ* a Resurrection get.

*Written on a Sun-Dial in a Circle.* 296

*Sic petit oceanum Phœbus, sic vita sepulchrum,  
Dum sensim tacita volvitur hora rota:  
Secula sic fugient, sic lux, sic umbra, theatrum  
Donec stelligerum clausurit una dies.*

*Afterwards turned into English:*

Thus steal the silent Hours away,  
'The Sun thus hastes to reach the Sea,  
And Men to mingle with their Clay.  
Thus Light and Shade divide the Year,  
'Till the last great Day appear  
To shut the starry Theatre.

}  
}  
}

ANOTHER.

297 So slide the Hours, so wears the Day,  
These Moments measure Life away,  
With all its Trains of Hope and Fear;  
'Till shifting Scenes of Shade and Light  
Rise to eternal Day, or sink in endless Night,  
Where all is Joy, or all Despair.



*On a Cieling Dial, usually called a Spot Dial,  
made at a western Window at Theobald's.*

- 298 Little Sun upon the Cieling,  
Ever moving, ever stealing  
Moments, Minutes, Hours away,  
May no Shade forbid thy shining,  
While the heav'nly Sun declining  
Calls us to improve the Day.

*Another for a Spot Dial.*

- 299 Shining Spot, but ever sliding!  
Brightest Hours have no abiding:  
Use the golden Moments well;  
Life is wasting,  
Death is hastening,  
Death consigns to Heav'n or Hell.

ANOTHER.

- 300 See the little Day-Star moving;  
Life and Time are worth improving:  
Seize the Moments while they stay,  
Seize and use them,  
Lest you lose them,  
And lament the wasted Day.

ANOTHER.

- 301 This plainly shews to foolish Man,  
That his whole Life is but a Span.

CHAP.

CHAP. XXIV. *A new Table of the Elevation of the Pole, and Difference of Meridians from London.*

**A** *New and Correct Alphabetical Table of the most eminent Cities, Towns, &c. in the World; \* shewing at each Place the Elevation of the Pole, and the Difference of their Meridian from London.*

✍ The *Elevation of the Pole* signifies the same Thing as the *Latitude of the Place*; and the *Difference of the Meridian*, the same as the *Longitude of the Place*.

Note,

|   |               |         |  |   |              |       |              |
|---|---------------|---------|--|---|--------------|-------|--------------|
| D | } signifies { | Degrees |  | E | } signifie { | East  | } Longitude. |
| H |               | Hours   |  | W |              | West  |              |
| M |               | Minutes |  | N |              | North |              |
|   |               |         |  | S |              | South | Latitude.    |

*An Explanation of the following Table.*

The *Names* of the Places stand in an *alphabetical Order*, and those *Names* are always followed by *One* or *Two* more in the same Line or Article. Where there is but *One* Name following *that* of the *Place*, it signifies what *Kingdom* or *Part of the World* it is situated in; as *Athens*, Greece, signifies that *Athens* is in Greece: But where there are *Two* Names following the Name of the *Place*, the *First* signifies the *Province* or *Division*, and the *Second* the *Kingdom* or *Part of the World*, as *Aix la Chapelle*, Westphalia, Germany, signifies that *Aix la Chapelle* is in Westphalia, which is a Province of Germany, and so of all the rest.

\* N. B. The Table of the principal Cities and Towns in England, Scotland, Ireland and Wales, is on Page 14, &c.

# 118 A new Table of the Elevation of the

|                                                 | Latit. |      | Dif. M.         |  |
|-------------------------------------------------|--------|------|-----------------|--|
|                                                 | D.     | M.   | H. M.           |  |
| A.                                              |        |      |                 |  |
| <i>Adrianople</i> , Turkey, Europe              | 43     | 18 N | 1 50 E          |  |
| <i>Agra</i> , a Capital in the Mogul's Empire   | 29     | 0 N  | 5 38 E          |  |
| <i>Aix</i> , Provence, France                   | 43     | 4 N  | 0 23 E          |  |
| <i>Aix la Chapelle</i> , Westphalia, Germany    | 50     | 48 N | 0 28 E          |  |
| <i>Alppo</i> , Syria, Asia                      | 37     | 0 N  | 2 45 E          |  |
| <i>Alexandria</i> , Egypt, Africa               | 31     | 25 N | 2 3 E           |  |
| <i>Alexandretta</i> , Syria, Asia               | 37     | 10 N | 2 31 E          |  |
| <i>Algiers</i> , Barbary, Africa                | 36     | 20 N | 0 9 E           |  |
| <i>Alicant</i> , Valentia, Spain                | 37     | 45 N | 0 1 E           |  |
| <i>Amsterdam</i> , Holland                      | 52     | 29 N | 0 20 E          |  |
| <i>Antibes</i> , Provence, France               | 43     | 15 N | 0 33 E          |  |
| <i>Antwerp</i> , Brabant                        | 51     | 16 N | 0 17 E          |  |
| <i>Archangel</i> , Russia                       | 64     | 30 N | 2 41 E          |  |
| <i>Arica</i> , Peru, South America              | 18     | 50 S | 4 59 W          |  |
| <i>Astracan</i> , near the Caspian Sea, Muscovy | 46     | 50 N | 3 26 E          |  |
| <i>Athens</i> , Greece                          | 37     | 25 N | 1 35 E          |  |
| <i>Augsburg</i> , Suabia, Germany               | 47     | 55 N | 0 43 E          |  |
| B.                                              |        |      |                 |  |
| <i>Babylon</i> , Chaldea                        | 34     | 30 N | 3 14 E          |  |
| <i>Bagdat</i> , Mesopotamia, Asia               | 33     | 0 N  | 3 2 E           |  |
| <i>Baldivia</i> , Chili, South America          | 40     | 0 S  | 5 12 W          |  |
| <i>Barbadoes</i> , West-Indies                  | 13     | 10 N | 3 59 W          |  |
| <i>Barcelona</i> , Catalonia, Spain             | 41     | 10 N | 0 8 E           |  |
| <i>Batavia</i> , Java, East Indies              | 6      | 5 S  | 7 6 E           |  |
| <i>Bayonne</i> , Gascony, France                | 43     | 30 N | 0 5 W           |  |
| <i>Belgrade</i> , Servia                        | 45     | 0 N  | 1 13 E          |  |
| <i>Belvedere</i> , Naples, Italy                | 39     | 35 N | 1 6 E           |  |
| <i>Benevente</i> , Spain                        | 41     | 55 N | 0 21 W          |  |
| <i>Beneventum</i> , Naples, Italy               | 41     | 13 N | 1 2 E           |  |
| <i>Bengal</i> , India                           | 21     | 0 N  | 5 12 E          |  |
| <i>Bergen</i> , Norway                          | 60     | 0 N  | 0 22 E          |  |
| <i>Berlin</i> , Germany                         | 52     | 10 N | 0 52 E          |  |
| <i>Bern</i> , Switzerland                       | 47     | 0 N  | 0 31 E          |  |
| <i>Bilboa</i> , Biscay, Spain                   | 43     | 10 N | 0 9 E           |  |
| <i>Bologna or Boulogne</i> , Italy              | 44     | 20 N | 0 48 E          |  |
| <i>Bonn</i> , Lower Rhine, Germany              | 50     | 30 N | 0 30 E          |  |
| <i>Boisteduc</i> , Brabant, Flanders            | 51     | 30 N | 0 20 E          |  |
| <i>Boston</i> , New England                     | 42     | 10 N | 4 28 W          |  |
| <i>Bordeaux</i> , Guienne, France               | 44     | 55 N | 0 3 E           |  |
| <i>Bouges</i> , Orleansois, France              | 46     | 54 N | 0 10 E          |  |
| <i>Brandenburgh</i> , Prussia, Germany          | 52     | 10 N | 0 50 E          |  |
| <i>Brest</i> , Bretagne, France                 | 48     | 34 N | 0 18 E          |  |
| <i>Breda</i> , Spanish Provinces                | 51     | 30 N | 0 17 E          |  |
| <i>Breslaw</i> , Bohemia, Germany               | 51     | 5 N  | 1 6 E           |  |
| <i>Brill</i> , Holland                          | 51     | 55 N | 0 25 E          |  |
| <i>Brindisi</i> , Naples, Italy                 | 40     | 48 N | 1 13 E          |  |
| <i>Brunswick</i> , Germany                      | 51     | 55 N | 0 46 E          |  |
|                                                 |        |      | <i>Bruges</i> , |  |



# Pole, and Difference of Meridians. 119

|                                           | Latit. |      | Dif. Me. |      |
|-------------------------------------------|--------|------|----------|------|
|                                           | D.     | M.   | H.       | M.   |
| <i>Bruges</i> , Flanders                  | 51     | 15 N | 0        | 12 E |
| <i>Brussels</i> , Flanders                | 50     | 48 N | 0        | 16 E |
| <i>Buda</i> , Lower Hungary               | 47     | 0 N  | 1        | 8 E  |
| C.                                        |        |      |          |      |
| <i>Cadiz</i> , Andalusia, Spain           | 37     | 5 N  | 0        | 23 W |
| <i>Caen</i> , Normandy, France            | 49     | 5 N  | 0        | 22 W |
| <i>Cagliari</i> , Sardinia, Mediterranean | 39     | 10 N | 0        | 38 E |
| <i>Cairo</i> , Egypt, Africa              | 30     | 10 N | 2        | 6 E  |
| <i>Calais</i> , France                    | 51     | 0 N  | 0        | 8 E  |
| <i>Calecute</i> , East-Indies             | 11     | 0 N  | 4        | 59 E |
| <i>Cambray</i> , France                   | 50     | 10 N | 0        | 13 E |
| <i>Candia</i> , in Candia-Island          | 34     | 55 N | 1        | 39 E |
| <i>Candia</i> , Ceylon, East-Indies       | 7      | 30 N | 5        | 22 E |
| <i>Cape of Good Hope</i>                  | 34     | 25 S | 1        | 6 E  |
| <i>Cartagena</i> , Spanish West-Indies    |        |      |          |      |
| <i>Carthage</i> , Murcia, Spain           | 37     | 0 N  | 0        | 2 E  |
| <i>Carthage</i> , Barbary, Africa         | 35     | 0 N  | 0        | 44 E |
| <i>Casal</i> , Milan, Italy               | 45     | 5 N  | 0        | 34 E |
| <i>Catanea</i> , Sicily                   | 37     | 20 N | 1        | 1 E  |
| <i>Ceuta</i> , Africa                     | 35     | 50 N | 0        | 23 W |
| <i>Charles Town</i> in Carolina           | 32     | 30 N | 5        | 24 W |
| <i>Christianstad</i> , Gothland, Sweden   | 56     | 35 N | 0        | 58 E |
| <i>Clermont</i> , Lioinois, France        | 45     | 40 N | 0        | 13 E |
| <i>Cleves</i> , Westphalia, Germany       | 51     | 40 N | 0        | 25 E |
| <i>Cochin</i> , Malabar, Asia             | 10     | 0 N  | 5        | 1 E  |
| <i>Cochin China</i> , East Indies, Asia   | 13     | 0 N  | 7        | 8 E  |
| <i>Cologne</i> , Germany                  | 50     | 40 N | 0        | 29 E |
| <i>Constantinople</i> , Romania, Turkey   | 41     | 6 N  | 1        | 59 E |
| <i>Copenhagen</i> , Zealand, Denmark      | 55     | 40 N | 0        | 50 E |
| <i>Corinth</i> , Morea, Turkey            | 38     | 0 N  | 1        | 30 E |
| <i>Cracow</i> , Poland                    | 50     | 15 N | 1        | 23 E |
| <i>Cremona</i> , Milan, Italy             | 45     | 10 N | 0        | 42 E |
| <i>Cusco</i> , Peru, South America        | 12     | 20 S | 4        | 48 W |
| <i>Cyprus Island</i> , Levant             | 35     | 0 N  | 2        | 16 E |
| D.                                        |        |      |          |      |
| <i>Dantzick</i> , Poland                  | 54     | 25 N | 1        | 18 E |
| <i>Darmstadt</i> , Upper Rhine, Germany   | 49     | 30 N | 0        | 37 E |
| <i>Delft</i> , Holland                    | 52     | 10 N | 0        | 17 E |
| <i>Derbent</i> , near the Caspian Sea     | 42     | 0 N  | 3        | 20 E |
| <i>Deventer</i> , United Provinces        | 51     | 56 N | 0        | 24 E |
| <i>Deux Ponts</i> , Upper Rhine, Germany  | 49     | 10 N | 0        | 29 E |
| <i>Doway</i> , Flanders                   | 50     | 12 N | 0        | 14 E |
| <i>Dresden</i> , Saxony, Germany          | 51     | 6 N  | 0        | 55 E |
| <i>Drontheim</i> , Norway                 | 63     | 0 N  | 0        | 41 E |
| <i>Dunkirk</i> , France                   | 51     | 7 N  | 0        | 10 E |
| <i>Durazzo</i> , Albania, Turkey          | 40     | 40 N | 1        | 11 E |

# 120 *A new Table of the Elevation of the*

|                                             | <i>Latit.</i> |      | <i>Dif. Me.</i> |
|---------------------------------------------|---------------|------|-----------------|
|                                             | D.            | M.   | H. M.           |
| <b>E.</b>                                   |               |      |                 |
| <i>Elbing</i> , Poland                      | 54            | 20 N | 1 22 E          |
| <i>Embsen</i> , Westphalia, Germany         | 53            | 10 N | 0 29 E          |
| <i>Ephesus</i> , Natolia, Asia              | 37            | 50 N | 1 50 E          |
| <b>F.</b>                                   |               |      |                 |
| <i>Ferrara</i> , Italy                      | 44            | 45 N | 0 49 E          |
| <i>Fiz</i> , Barbary, Africa                | 33            | 15 N | 0 24 W          |
| <i>Finale</i> , Genoa, Italy                | 44            | 10 N | 0 34 E          |
| <i>Florence</i> , Tuscany, Italy            | 43            | 40 N | 0 47 E          |
| <i>Fort St. George</i> , East Indies        | 13            | 0 N  | 5 20 E          |
| <i>Frankfort</i> on the Oder, Germany       | 52            | 28 N | 0 58 E          |
| <i>Frankfort</i> on the Main, Germany       | 49            | 45 N | 0 39 E          |
| <i>Frieberg</i> , Suabia, Germany           | 47            | 50 N | 0 33 E          |
| <i>Furnes</i> , Flanders                    | 51            | 15 N | 0 11 E          |
| <b>G.</b>                                   |               |      |                 |
| <i>Gallipoli</i> , Romania, Turkey          | 40            | 55 N | 1 53 E          |
| <i>Gelders</i> , Gelderland                 | 51            | 15 N | 0 26 E          |
| <i>Geneva</i> , Savoy, Italy                | 46            | 15 N | 0 25 E          |
| <i>Genoa</i> , Italy                        | 44            | 25 N | 0 37 E          |
| <i>Ghent</i> , Flanders                     | 51            | 6 N  | 0 14 E          |
| <i>Gibraltar</i> , Andalusia, Spain         | 35            | 30 N | 0 19 E          |
| <i>Glatz</i> , Bohemia, Germany             | 50            | 30 N | 1 7 E           |
| <i>Goa</i> , East-Indies                    | 15            | 22 N | 4 58 E          |
| <i>Gombroon</i> , Persian Gulf              | 7             | 10 N | 3 44 E          |
| <i>Gottenburgh</i> , Sweeden                | 57            | 30 N | 0 48 E          |
| <i>Granada</i> , Granada, Spain             | 36            | 20 N | 0 11 E          |
| <i>Graveling</i> , Flanders                 | 51            | 4 N  | 0 10 E          |
| <i>Grenoble</i> , Dauphine, France          | 45            | 10 N | 0 23 E          |
| <i>Grodno</i> , Lithuania, Poland           | 53            | 25 N | 1 40 E          |
| <i>Groeningen</i> , Holland                 | 53            | 5 N  | 0 23 E          |
| <b>H.</b>                                   |               |      |                 |
| <i>Hague</i> , Holland                      | 52            | 10 N | 0 16 E          |
| <i>Hall</i> , Swabia, Germany               | 49            | 6 N  | 0 41 E          |
| <i>Hamburgh</i> , Denmark                   | 53            | 30 N | 0 40 E          |
| <i>Hanaw</i> , Upper Rhine, Germany         | 50            | 3 N  | 0 41 E          |
| <i>Hanover</i> , Saxony, Germany            | 52            | 16 N | 0 36 E          |
| <i>Harlem</i> , Holland                     | 52            | 25 N | 0 17 E          |
| <i>Heidelberg</i> , Lower Rhine, Germany    | 49            | 12 N | 0 35 E          |
| <i>Helmstat</i> , Saxony, Germany           | 51            | 52 N | 0 49 E          |
| <i>Hulst</i> , Flanders                     | 51            | 20 N | 0 19 E          |
| <b>I.</b>                                   |               |      |                 |
| <i>James Town</i> , Virginia, North America | 37            | 10 N | 5 0 W           |
| <i>Jerusalem</i> , Palestine, Asia          | 32            | 44 N | 2 21 E          |
| <i>Ingolstat</i> , Bavaria, Germany         | 48            | 32 N | 0 52 E          |
| <i>Ispahan</i> , Ancient Persia, Asia       | 33            | 0 N  | 3 33 E          |
| <i>Juliers</i> , Westphalia, Germany        | 50            | 20 N | 0 27 E          |
| <b>K.</b>                                   |               |      |                 |
| <i>Kaminaick</i> , Podolia, Poland          | 49            | 20 N | 1 38 E          |

*Kargapol.*

# Pole, and Difference of Meridians. 121

|                                                      | Latit. |      | Dif. Me.     |      |
|------------------------------------------------------|--------|------|--------------|------|
|                                                      | D.     | M.   | H.           | M.   |
| <i>Kargapol</i> , Russia                             | 61     | 30 N | 2            | 49 E |
| <i>Kexholm</i> , Finland, Sweeden                    | 61     | 20 N | 2            | 4 E  |
| <i>Koningsburgh</i> , Prussia, Poland                | 54     | 55 N | 1            | 29 E |
| <i>Konizeck</i> or <i>Koniox</i> , Poland            | 54     | 15 N | 1            | 15 E |
| L                                                    |        |      |              |      |
| <i>Landau</i> , Suabia, Germany                      | 48     | 50 N | 0            | 33 E |
| <i>Laodicea</i> , Natolia, Asia                      | 38     | 10 N | 1            | 58 E |
| <i>Larissa</i> , Thessaly, Turkey in Europe          | 39     | 30 N | 1            | 29 E |
| <i>Larta</i> , Epirus, Greece, now Turkey            | 39     | 0 N  | 1            | 17 E |
| <i>Lawenburgh</i> , Saxony, Germany                  | 53     | 20 N | 0            | 43 E |
| <i>Legorn</i> or <i>Leghorn</i> , Tuscany, Italy     | 43     | 40 N | 0            | 45 E |
| <i>Lepanto</i> , Achaia, Turkey                      | 38     | 30 N | 1            | 23 E |
| <i>Lerida</i> , Catalonia, Spain                     | 41     | 15 N | 0            | 3 E  |
| <i>Lewwarden</i> , West Friesland, Holland           | 53     | 0 N  | 0            | 26 E |
| <i>Leyden</i> , Holland                              | 52     | 10 N | 0            | 14 E |
| <i>Leipsick</i> , Germany                            | 50     | 50 N | 0            | 51 E |
| <i>Leige</i> , Spanish Provinces                     | 50     | 25 N | 0            | 22 E |
| <i>Lima</i> , Peru, South America                    | 11     | 30 S | 5            | 15 W |
| <i>Lisle</i> , Flanders                              | 50     | 40 N | 0            | 11 E |
| <i>Lisbon</i> , Portugal                             | 38     | 45 N | 0            | 53 W |
| <i>Livorn</i> , see <i>Leghorn</i>                   |        |      |              |      |
| L O N D O N, Metropolis of England                   | 51     | 32 N | 0            | 0    |
| <i>Loretto</i> , Tuscany, Italy                      | 43     | 36 N | 0            | 59 E |
| <i>Louvain</i> , Spanish Provinces                   | 50     | 40 N | 0            | 19 E |
| <i>Lubeck</i> , Holstein, Denmark                    | 54     | 10 N | 0            | 45 E |
| <i>Lucca</i> , Tuscany, Italy                        | 43     | 50 N | 0            | 44 E |
| <i>Lunden</i> , Gothland, Sweeden                    | 55     | 30 N | 0            | 54 E |
| <i>Luxemburgh</i> , Saxony, Germany                  | 53     | 10 N | 0            | 43 E |
| <i>Luxemburgh</i> , France                           | 49     | 20 N | 0            | 25 E |
| <i>Lions</i> , Lionois, France                       | 45     | 40 N | 0            | 19 E |
| M.                                                   |        |      |              |      |
| <i>Madagascar</i> , Africa                           | 19     | 29 S | 2            | 56 E |
| <i>Madrid</i> , New Castile, Spain                   | 40     | 10 N | 0            | 14 W |
| <i>Maestrecht</i> , Spanish Provinces                | 50     | 34 N | 0            | 23 E |
| <i>Magdeburgh</i> , Saxony, Germany                  | 51     | 45 N | 0            | 50 E |
| <i>Majorca</i> , in the Mediterranean                | 39     | 0 N  | 0            | 10 E |
| <i>St. Maloes</i> , Bretagne, France                 | 48     | 38 N | 0            | 9 W  |
| <i>Malaga</i> , Granada, Spain                       | 36     | 0 N  | 0            | 16 W |
| <i>Malta</i> , near Sicily, Mediterranean            | 35     | 50 N | 0            | 56 E |
| <i>Malacca</i> , East-Indies                         | 2      | 8 N  | 6            | 42 E |
| <i>Mantua</i> , Italy                                | 45     | 16 N | 0            | 47 E |
| <i>Marseilles</i> , Provence, France                 | 43     | 15 N | 0            | 23 E |
| <i>Mecca</i> , Arabia Felix                          | 21     | 30 N | 2            | 34 E |
| <i>Mechlin</i> or <i>Malines</i> , Spanish Provinces | 50     | 50 N | 0            | 9 E  |
| <i>Medina</i> , Arabia Felix                         | 24     | 15 N | 2            | 22 E |
| <i>Mentz</i> or <i>Mayence</i> , Germany             | 49     | 44 N | 0            | 33 E |
| <i>Messina</i> , Sicily                              | 38     | 10 N | 1            | 3 E  |
|                                                      |        |      | <i>Metz,</i> |      |



# 122 *A new Table of the Elevation of the*

|                                                    | Latit. |      | Dif. Me. |      |
|----------------------------------------------------|--------|------|----------|------|
|                                                    | D.     | M.   | H.       | M.   |
| <i>Metz</i> , Lorain, Germany                      | 48     | 50 N | 0        | 24 E |
| <i>Mexico</i> , North America                      | 10     | 0 N  | 6        | 56 W |
| <i>St. Michael</i> , see Arch-Angel                |        |      |          |      |
| <i>Milan</i> , Italy                               | 45     | 28 N | 0        | 38 E |
| <i>Minski</i> , Lithuania, Poland                  | 54     | 6 N  | 1        | 53 E |
| <i>Minorca</i> Island, Mediterranean               | 39     | 10 N | 0        | 16 E |
| <i>Mittau</i> , Courland                           | 56     | 25 N | 1        | 40 E |
| <i>Modena</i> , Italy                              | 44     | 30 N | 0        | 47 E |
| <i>Montpelier</i> , Languedoc, France              | 43     | 28 N | 0        | 16 E |
| <i>Mons</i> , Spanish Provinces                    | 50     | 20 N | 0        | 15 E |
| <i>Morlaix</i> , Bretagne, France                  | 48     | 38 N | 0        | 15 W |
| <i>Moscow</i> , Capital of Muscovy                 | 55     | 30 N | 2        | 38 E |
| <i>Munster</i> , Westphalia, Germany               | 51     | 45 N | 0        | 31 E |
| <i>Muncken</i> or <i>Munich</i> , Bavaria, Germany | 47     | 45 N | 0        | 46 E |
| N.                                                 |        |      |          |      |
| <i>Namur</i> , Flanders                            | 50     | 10 N | 0        | 23 E |
| <i>Nancy</i> , Lorrain, France                     | 48     | 32 N | 0        | 27 E |
| <i>Nantz</i> , Bretagne, France                    | 47     | 12 N | 0        | 6 E  |
| <i>Nankin</i> or <i>Nanquin</i> , China            | 31     | 0 N  | 7        | 54 E |
| <i>Naples</i> , Italy                              | 41     | 45 N | 0        | 59 E |
| <i>Narva</i> , Livonia, Sweeden                    | 58     | 55 N | 2        | 2 E  |
| <i>Narbonne</i> , Languedoc, France                | 42     | 50 N | 0        | 12 E |
| <i>Nassaw</i> , Upper Rhine, Germany               | 50     | 0 N  | 0        | 32 E |
| <i>Newmark</i> , Transylvania                      | 47     | 30 N | 1        | 26 E |
| <i>Nice</i> or <i>Nizza</i> , Piedmont, Italy      | 43     | 40 N | 0        | 29 E |
| <i>Nismes</i> , Languedoc, France                  | 43     | 30 N | 0        | 18 E |
| <i>Natteburg</i> , Ingria, Sweeden                 | 60     | 0 N  | 2        | 5 E  |
| <i>Novogrod</i> , Weliki, Russia                   | 58     | 10 N | 2        | 9 E  |
| <i>Nuremberg</i> , Franconia, Germany              | 49     | 0 N  | 0        | 45 E |
| O.                                                 |        |      |          |      |
| <i>Olmutz</i> , Bohemia, Germany                   | 49     | 32 N | 1        | 10 E |
| <i>St. Omers</i> , Flanders                        | 50     | 50 N | 0        | 9 E  |
| <i>Orange</i> , Provence, France                   | 44     | 10 N | 0        | 19 E |
| <i>Oran</i> , Barbary, Africa                      | 35     | 30 N | 0        | 0 E  |
| <i>Oresca</i> , see Notteburg                      |        |      |          |      |
| <i>Orleans</i> , Orleanois, France                 | 47     | 45 N | 0        | 7 E  |
| <i>Orvieto</i> , Papacy, Italy                     | 42     | 27 N | 0        | 53 E |
| <i>Otranto</i> , Naples, Italy                     | 40     | 52 N | 1        | 15 E |
| <i>Oudenard</i> , Flanders                         | 50     | 46 N | 0        | 13 E |
| <i>Oviedo</i> , Austria, Spain                     | 43     | 10 N | 0        | 23 W |
| P.                                                 |        |      |          |      |
| <i>Padua</i> , Italy                               | 35     | 32 N | 0        | 50 E |
| <i>Palermo</i> , Sicily                            | 37     | 26 N | 2        | 30 E |
| <i>Panama</i> , America                            | 1      | 10 S | 5        | 30 W |
| <i>Paris</i> , France                              | 48     | 45 N | 0        | 9 E  |
| <i>Parma</i> , Italy                               | 44     | 42 N | 0        | 44 E |
| <i>Pavia</i> , Milan, Italy                        | 45     | 12 N | 0        | 38 E |

*Pekin*

# Pole, and Difference of Meridians. 123

|                                           | Latit. |      | Dif. Me. |      |
|-------------------------------------------|--------|------|----------|------|
|                                           | D.     | M.   | H.       | M.   |
| <i>Pekin, China</i>                       | 39     | 52 N | 7        | 23 E |
| <i>Pergamos, Natolia, Asia</i>            | 37     | 50 N | 1        | 57 E |
| <i>Petersburg, Russia</i>                 | 59     | 25 N | 1        | 59 E |
| <i>Philadelphia, Natolia, Asia</i>        | 38     | 35 N | 1        | 58 E |
| <i>Pisa, Tuscany, Italy</i>               | 43     | 55 N | 0        | 45 E |
| <i>Placentia, Parma, Italy</i>            | 44     | 50 N | 0        | 41 E |
| <i>Pleskow, Russia</i>                    | 58     | 10 N | 2        | 16 E |
| <i>Ploozko, Poland</i>                    | 52     | 35 N | 1        | 22 E |
| <i>Poitiers, Orleanois, France</i>        | 46     | 30 N | 0        | 1 E  |
| <i>Porto or Oporto, Portugal</i>          | 40     | 52 N | 0        | 31 W |
| <i>Port Royal, Jamaica</i>                | 17     | 40 N | 5        | 4 W  |
| <i>Prague, Bohemia, Germany</i>           | 50     | 0 N  | 0        | 58 E |
| Q.                                        |        |      |          |      |
| <i>Quebeck, Canada</i>                    | 47     | 10 N | 4        | 41 W |
| <i>St. Quintin, Picardy, France</i>       | 49     | 50 N | 0        | 12 E |
| R.                                        |        |      |          |      |
| <i>Ratisbon, Bavaria, Germany</i>         | 48     | 34 N | 0        | 49 E |
| <i>Ravenna, Italy</i>                     | 44     | 25 N | 0        | 51 E |
| <i>Rennes, Bretagne, France</i>           | 48     | 12 N | 0        | 6 E  |
| <i>Reims, Champagne, France</i>           | 49     | 20 N | 0        | 16 E |
| <i>Rhodes Island, Archipelago</i>         | 35     | 30 N | 1        | 57 E |
| <i>Riga, Livonia</i>                      | 57     | 0 N  | 1        | 39 E |
| <i>Rochel, Orleanois, France</i>          | 45     | 55 N | 0        | 3 E  |
| <i>ROME, Italy</i>                        | 42     | 8 N  | 0        | 52 E |
| <i>Rotterdam, Holland</i>                 | 51     | 50 N | 0        | 17 E |
| <i>Rouen or Roan, Normandy, France</i>    | 49     | 15 N | 0        | 5 E  |
| S                                         |        |      |          |      |
| <i>Saltsburgh, Bavaria, Germany</i>       | 47     | 20 N | 0        | 54 E |
| <i>Salamanca, Leon, Spain</i>             | 40     | 45 N | 0        | 19 E |
| <i>Salonichi, Thessalonica, Turkey</i>    | 40     | 42 N | 1        | 31 E |
| <i>Salerno, Naples, Italy</i>             | 41     | 8 N  | 1        | 3 E  |
| <i>Sallee, Africa</i>                     | 22     | 25 N | 0        | 31 E |
| <i>Samarcand, Tartary</i>                 | 40     | 0 N  | 4        | 15 E |
| <i>Santillana, Austria, Spain</i>         | 43     | 10 N | 0        | 14 W |
| <i>Saragosa, Aragon, Spain</i>            | 41     | 20 N | 0        | 3 W  |
| <i>Sardis, Natolia, Asia</i>              | 38     | 10 N | 1        | 56 E |
| <i>Savona, Genoa, Italy</i>               | 44     | 25 N | 0        | 36 E |
| <i>Scanderoon, see Alexandretta</i>       | 37     | 10 N | 2        | 31 E |
| <i>Schaffhausen, Switzerland, Germany</i> | 47     | 28 N | 0        | 35 E |
| <i>Segovia, Old-Castile, Spain</i>        | 40     | 36 N | 0        | 15 E |
| <i>Sens, Champagne, France</i>            | 48     | 0 N  | 0        | 13 E |
| <i>Setines, see Athens</i>                |        |      |          |      |
| <i>Seville, Andalusia, Spain</i>          | 37     | 0 N  | 0        | 20 W |
| <i>Siam, East-Indies</i>                  | 14     | 5 N  | 6        | 43 E |
| <i>Sleswick, Denmark</i>                  | 55     | 57 N | 0        | 39 E |
| <i>Smolensko, Muscovy</i>                 | 54     | 55 N | 2        | 14 E |
| <i>Smyrna, Natolia, Asia</i>              | 38     | 4 N  | 1        | 56 E |

*Soissons,*

# 124 *A new Table of the Elevation of the*

|                                                        | Latit. |      | Dif. Me. |      |
|--------------------------------------------------------|--------|------|----------|------|
|                                                        | D.     | M.   | H.       | M.   |
| <i>Soissons</i> , France                               | 49     | 20 N | 0        | 14 E |
| <i>Sophia</i> , Bulgaria, Turkey                       | 42     | 32 N | 1        | 30 E |
| <i>Spalato</i> , Dalmatia, Turkey                      | 43     | 20 N | 1        | 2 E  |
| <i>Spies</i> , Upper Rhine, Germany                    | 49     | 0 N  | 0        | 33 E |
| <i>Spoletto</i> , Italy                                | 42     | 28 N | 0        | 55 E |
| <i>Stockholm</i> , Sweden                              | 59     | 30 N | 1        | 16 E |
| <i>Strasburg</i> , Upper Rhine, Germany                | 48     | 17 N | 0        | 31 E |
| <i>Sultzback</i> , Bavaria, Germany                    | 49     | 10 N | 0        | 47 E |
| <i>Surat</i> , India                                   | 21     | 30 N | 4        | 47 E |
| <i>Syracuse</i> , Sicily                               | 35     | 15 N | 1        | 0 E  |
| T.                                                     |        |      |          |      |
| <i>Tangier</i> , Barbary, Africa                       | 35     | 45 N | 0        | 24 W |
| <i>Taranto</i> , Naples, Italy                         | 40     | 40 N | 1        | 11 E |
| <i>Tarragon</i> , Catalonia, Spain                     | 40     | 55 N | 0        | 5 E  |
| <i>Temefwaer</i> , Hungary                             | 45     | 30 N | 1        | 15 E |
| <i>Tetuan</i> , Fez, Africa                            | 35     | 30 N | 0        | 22 E |
| <i>Tibet</i> , see Stives                              |        |      |          |      |
| <i>Tbolause</i> or <i>Toulouse</i> , Languedoc, France | 43     | 15 N | 0        | 7 E  |
| <i>Tborn</i> , Poland                                  | 53     | 0 N  | 1        | 18 E |
| <i>Tbyatira</i> , Natolia, Asia                        | 38     | 28 N | 1        | 54 E |
| <i>Tokay</i> , Hungary                                 | 48     | 12 N | 1        | 15 E |
| <i>Toledo</i> , New-Castile, Spain                     | 39     | 30 N | 0        | 14 W |
| <i>Tortosa</i> , Catalonia, Spain                      | 40     | 34 N | 0        | 2 E  |
| <i>Torneo</i> or <i>Torno</i> , Lapland                | 65     | 50 N | 1        | 34 E |
| <i>Tours</i> , Orleanois, France                       | 47     | 10 N | 0        | 4 E  |
| <i>Toulon</i> , Provence, France                       | 43     | 0 N  | 0        | 25 E |
| <i>Tournay</i> , Flanders                              | 50     | 35 N | 0        | 14 E |
| <i>Trent</i> , Austria, Germany                        | 45     | 50 N | 0        | 46 E |
| <i>Treves</i> or <i>Triers</i> , Lower Rhine, Germany  | 49     | 30 N | 0        | 27 E |
| <i>Tripoli</i> , Barbary, Africa                       | 33     | 5 N  | 0        | 55 E |
| <i>Tunis</i> , Barbary, Africa                         | 35     | 30 N | 0        | 51 E |
| <i>Turin</i> , Piedmont, Italy                         | 44     | 50 N | 0        | 31 E |
| V.                                                     |        |      |          |      |
| <i>Valencia</i> , Valencia, Spain                      | 39     | 15 N | 0        | 1 E  |
| <i>Valladolid</i> , Old-Castile, Spain                 | 41     | 28 N | 0        | 15 W |
| <i>Vendosme</i> , Orleanois, France                    | 47     | 45 N | 0        | 4 E  |
| <i>Venloe</i> , Gelderland                             | 51     | 10 N | 0        | 25 E |
| <i>Venice</i> , Italy                                  | 45     | 36 N | 0        | 51 E |
| <i>Verdun</i> , Lorrain, Germany                       | 49     | 10 N | 0        | 21 E |
| <i>Verona</i> , Venice, Italy                          | 45     | 25 N | 0        | 48 E |
| <i>Vienna</i> , Austria, Germany                       | 48     | 12 N | 1        | 7 E  |
| <i>Vienne</i> , Dauphine, France                       | 45     | 26 N | 2        | 43 E |
| <i>Ulm</i> , Suabia, Germany                           | 47     | 55 N | 0        | 41 E |
| <i>Upsal</i> , Sweden                                  | 59     | 55 N | 1        | 14 E |
| <i>Utrecht</i> , Holland                               | 52     | 0 N  | 0        | 20 E |
| W.                                                     |        |      |          |      |
| <i>Warsaw</i> , Poland                                 | 52     | 10 N | 1        | 28 E |
| <i>Waterford</i> ,                                     |        |      |          |      |



## Pole, and Difference of Meridians. 125

|                                                    | Latit. |      | Dif. M. |      |
|----------------------------------------------------|--------|------|---------|------|
|                                                    | D.     | M.   | H.M.    |      |
| <i>Waterford</i> , Ireland                         | 53     | 0 N  | 0       | 29 W |
| <i>Wesel</i> , Westphalia, Germany                 | 51     | 32 N | 0       | 26 E |
| <i>Wiberg</i> , Jutland, Denmark                   | 56     | 25 N | 0       | 37 E |
| <i>Wittenbergh</i> , Saxony, Germany               | 51     | 28 N | 0       | 53 E |
| <i>Wolfenbuttel</i> , Brunswick, Germany           | 51     | 50 N | 0       | 43 E |
| <i>Worme</i> , Germany                             | 49     | 12 N | 0       | 34 E |
| <i>Wurtsburg or Wirtsburg</i> , Franconia, Germany | 49     | 20 N | 0       | 41 E |
| Y.                                                 |        |      |         |      |
| <i>Yvica</i> , Mediterranean                       | 38     | 40 N | 0       | 5 E  |
| Z.                                                 |        |      |         |      |
| <i>Zell</i> , Lunenburgh, Germany                  | 52     | 30 N | 0       | 42 E |
| <i>Zolnock</i> , Hungary                           | 47     | 58 N | 1       | 13 E |
| <i>Zurick</i> , Swtizerland, Germany               | 47     | 15 N | 0       | 33 E |
| <i>Zutphen</i> , Gelderland, Holland               | 52     | 4 N  | 0       | 24 E |

### CHAP. XXV. Concerning the Motion of the Hands of a Clock or Watch, as it re- presents the Motion of the Sun and Moon.

FOR a Conclusion of this Work, I shall here shew my Reader how naturally the *two* Hands of a *Clock* or *Watch* represent the Motions of the *Sun* and *Moon*: For as there are *twelve* Calender Months, and *twelve* Signs in the Zodiack, so also are there *twelve* Hours upon the Dial Plate of a *Clock* and *Watch*. But as the *Moon* makes *thirteen* Conjunctions with the *Sun* in *one* Year, that is, in the Time the *Sun* *apparently* moves once round the Heavens, so the *Minute-Hand* of a *Clock* or *Watch* makes but *eleven* Conjunctions with the *Hour-hand* in the Time it moves *once* round. For let the *Hour-hand* represent the *Sun*, and the *Minute-hand* the *Moon*, at *12 a-clock* they are *always* together, then they both moving forward, when the *Minute-hand* comes again to *12*, it doth not find the *Hour-hand* there,

but

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but is moved *one eleventh* Part of the whole Revolution further; therefore the *Minute-hand* must go 5 Min. 27 Sec. 16 Thirds 21 Fourths 49 Fifths  $\frac{1}{11}$ , before it make the *next Conjunction* with the *Hour-hand*. And

Just so it is with the *Sun* and *Moon*; for supposing the *new Moon* to be upon the 21st Day of *March* in the very beginning of *Aries*, they both moving forward according to the order of the Signs.

When the *Moon* comes again to the very *beginning* of *Aries*, she doth not find the *Sun* there, he is moved 26 Deg. 55 Min. 46 Sec. more to the *East* in the *Ecliptick*,\* so that the next *Conjunction* of the *Sun* and *Moon* will be made in *Aries* 29 Deg. 6 Min. 25 Sec. 12 Thirds, according to their *middle Motions*; and the next or *second new Moon* would be made in *Taurus* 28 Deg. 12 Min. 50 Sec. 24 Thirds; the *Third* in *Gemini* 27 Deg. 19 Min. 15 Sec. 36 Thirds; the *Fourth* in *Cancer* 26 Deg. 25 Min. 40 Sec. 48 Thirds, &c. every *new Moon* exceeding the Place of the foregoing by 29 Deg. 6 Min. 25 Sec. 12 Thirds, but they do not move equally as doth the Hands of a *Clock* or *Watch*. Therefore the above *equal Law* of the *Sun* and *Moon* is not exactly observed; however, this may serve well enough to give an *Idea* of the *new Moons*, how it is nothing else but the passing of the *Moon* by the *Sun*, as the *Minute-hand* of a *Watch* doth by the *Hour-hand*, as represented by the following Table.

\* See my *Uranoscopia*, page 166.

# Ch. XXV. Of the Hands of a Clock, &c. 127

A New and Correct Table, shewing the exact Time that the Hands of a Clock or Watch meet through one Revolution, or the whole 12 Hours upon the Dial Plate of a Clock, &c.

| N  | Hours | H  | i  | ii | iii | iv | v                  |
|----|-------|----|----|----|-----|----|--------------------|
| 0  |       |    |    |    |     |    |                    |
| 1  | 1     | 1  | 5  | 27 | 16  | 21 | 49 $\frac{1}{11}$  |
| 2  | 2     | 2  | 10 | 54 | 32  | 43 | 38 $\frac{2}{11}$  |
| 3  | 3     | 3  | 16 | 21 | 49  | 5  | 27 $\frac{3}{11}$  |
| 4  | 4     | 4  | 21 | 49 | 5   | 27 | 16 $\frac{4}{11}$  |
| 5  | 5     | 5  | 27 | 16 | 21  | 49 | 5 $\frac{5}{11}$   |
| 6  | 6     | 6  | 32 | 43 | 38  | 10 | 54 $\frac{6}{11}$  |
| 7  | 7     | 7  | 38 | 10 | 54  | 32 | 43 $\frac{7}{11}$  |
| 8  | 8     | 8  | 43 | 38 | 10  | 54 | 32 $\frac{8}{11}$  |
| 9  | 9     | 9  | 49 | 5  | 27  | 16 | 21 $\frac{9}{11}$  |
| 10 | 10    | 10 | 54 | 32 | 43  | 38 | 10 $\frac{10}{11}$ |
| 11 | 12    | 12 | 00 | 00 | 00  | 00 | 00                 |

## EXPLANATION.

The first Column to the left Hand shews the Number of *Conjunctions* of the *Hour* and *Minute-hand*, the *second* contains the *Hours*, the *third* the exact *Times* of their *meeting*.

*As for Example.*

The *two Hands* are *together* at 12 a-clock, and the *next Time* they will be *together* will be at 5 M. 27 Sec. 16 Thirds, 21 Fourths, 49 Fifths  $\frac{1}{11}$  past one, the *third Meeting* will be at 10 M. 54 S. &c. past 2, the *fourth* at 16 M. 21 S. &c. past 3 a-clock, &c. as in the Table, and this is plain enough without any more Examples.

C H A P.



CHAP. XXVI. *Of PAINTING Sun Dials,  
and first of the Planes or Surfaces on which  
DIALS are to be drawn.*

*DIAL* Planes are of *two* Sorts; *first* such as are made on the Wall of a Building; or *secondly*, such as are drawn on Tables of Wood, vulgarly called *Dial-Boards*.

The *first Sort*, if they are made on *Brick-Work*, is done by plaistering on the Wall with Lime, Sand and Hair, mixed; this must be well drenched with *Linseed Oil*, after it is dry, *i. e.* as long as it will drink any; and then painted with Oil and White-Lead, that it may be durable.

But a better way is to temper the Lime, Sand and Hair with Ox Blood, which will be no great Charge, but of great Advantage; for this Mixture will equal in Time the hardness of a Free-Stone, and keep the Surface as free from the Injuries of Weather; but you must afterwards paint it white. The following Method is still preferable.

*How to make an exceeding strong Cement or Plaister, with which to form any Dial Plane upon the Side of a House or Wall, which will endure the Weather, not inferior to Stone.*

Take *Lime* and *Sand*, and temper it with *Linseed Oil* to the Consistency of *Mortar*, or common Plaister, and spread it upon the Wall to a *competent* Thickness, and it will become as hard as a Stone, and last many Ages; and upon this you may describe a Dial, and put on the Lines, Figures and Furniture, as hereafter is directed.

*Note,*

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*Note*, If you are in the Country, remote from any Opportunity of getting *Linseed Oil*, you may make it with *skimmed Milk*, which will be much superior to Plaister made with Lime, Hair and Water.

If you are to draw a Dial upon a *Stone*, the best Way is to *drench* the Stone with *Linseed Oil* and *White-Lead* mixed *very thin*, till it will drink in no more; then shall the *Dial* you paint upon it, last longer, and be the better prepared against the Ruins of Time.

Now for Tables or *Dial Boards* of *Wood*, they being the most common, I shall give such Directions for making them, as have been always found most profitable and fit for the Purpose.

The best Woods for this Purpose, are the *clearest Wainscot*, and *yellow Fir*, provided it is clear of dead turpentine Knots; there is not much Difference between these two Woods, as to their Alteration by the Weather, they being both subject to split in case they *are bound*, and have not free Liberty to *shrink* with dry Weather, and *swell* with Wet, though as to their lasting, Oak seems preferable; though good *yellow Fir* will last the Age of an ordinary Man, if well secured, as Things of this Nature ought to be.

In working either of these kinds of Woods, the Boards ought first to be cut to such a Length as you intend your *Dial Board* shall be, and so many of them as may make up the Breadth designed, and let them be joined on the Edges, and plained on both Sides, and afterwards set to dry.

*For it has been observed, that though Boards have lain in a House ever so long, and are ever so dry, yet when they are thus shot and plained, they will shrink afterwards beyond Belief, if kept dry.*

K

When

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When you think they are dry enough, and will shrink no more, let them be shot again with good Joints, and let every Joint be secured with wooden *Dove-Tails*, let in a-cross the Joint in the *Backside*; let this be done after the Boards are glued together and well dried: after it has been thus glued, and the Joints are sufficiently dry, then let the *Face* of the Board be well plained and tried every Way that it may be both *smooth* and *true*, and the Edges shot true and all of a Thickness, as Pannels of Wainscot are commonly wrought.

The *Edges* must be true and even, that they may fit into the *Rabit* of a Moulding, put round it, just as a Pannel of Wainscot does in its Frame.

This Method will give Liberty to the Board to *shrink* without tearing; whereas Mouldings that are nailed round the Edges, as the common Way is, do so restrain the Motion of the Wood, that it cannot *shrink* without tearing; but Boards made this Way will last a long Time, without either parting in the Joints or splitting in the Wood.

*Dials* are some Times drawn on Planes lined with *Copper* or *Lead*, that they may be free from splitting or tearing; but a Board (*if it be made as before directed*) is to be preferred in many Respects. As *first*, In that it is much cheaper. *Secondly*, Both *Lead* and *Copper* will swell a little with the Heat of the Sun, and in Time will grow *hollow outwards*, or become *convex* instead of a perfect *Flat*, which will much pervert the Truth of its Shadow. And, *thirdly*, The Colours will be apt to peel from the Metal, and the Dial will by that means be in danger to be sooner defaced, than if it were painted upon a wooden Plane.

*How*



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*How to make the best Glue for gluing the Joints of Boards for Dials.*

Take a *Quart of Milk* (but some have preferred *Water*) that has stood so long and been skimmed so often that no more Cream will arise; and when skimmed very clean boil it a little in a *leaden Pot*, and if any Skum yet arise be sure to take it clean off; then put into the Milk about *half a Pound* of good Glue cut in small Bits, which will soon melt: boil it gently on a soft Fire to a *good body*, but not to be too thick nor too thin; then take it off the Fire and keep it for Use. *Note*, Care must be taken in the boiling that it do not *burn to the Sides of the Pot*, for that takes away much of the Strength of the Glue; but if it be made with due Care, it binds beyond any other Glue, and it is better able to resist the Weather, and therefore the fittest for gluing Boards for Sun Dials.

Care must be taken that your Glue be not made *too thin*, for if it be, the Wood will *so drink it up* that it will not be of a *sufficient Body* to bind the Parts together; on the contrary, if it be *too thick*, it will not give Way for the Joint to *shut close enough* to be strongly joined; for though it is Glue that makes the Joints stick, yet where there is so much of it that the Joint cannot close exactly, it will never hold firmly.

Whenever you use your Glue take care that it be *thoroughly hot*, for Glue that is not hot never takes firm hold on the Wood.

You must also take great care that the Boards you are to glue have not been touched with *Oil or Grease*; for in such Places the Glue will never take hold, although after a Thing is once glued fast, no Grease nor Oil can hurt it.

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The Glue being ready, and the Joints of the Board shot true, set *both* the Faces of the Joint close together, and both also *turned upward*; then dip a Brush in the Glue and besmear the Faces of both Joints *as quick as possible*, then clap the two Faces of the Joint together, and *slide or rub them long ways* one upon another two or three Times to settle them close, and so let them stand till they are firm and dry.

#### *How to prepare your Oil for laying on the Colours upon Dials.*

Take One Gallon of *Linseed Oil* and set it upon a *Charcoal Fire*, and when it is about to boil put into it *two Pounds of Red Lead*, and let it boil together for *about an Hour*; but the best Way to know when it is boiled enough, is to take a little of it out, and let it cool, and then if it *ropes like thin Tar*, it is enough: This done, put a *lighted Paper* to it, and set it on fire to consume the greasy Part of it, which will be done in a Minute or two, more or less, according to the Quantity of your Oil; and when it has burnt *long enough* clap a Cloth or any other Thing close over it, and extinguish the Fire; after which let it *cool and settle*, then decant the *clear Oil* from the Dregs, and keep it *in a Bladder* for Use.

This is called *drying Oil*, and with this the several Colours are to be ground in order to paint, so as *to endure the Weather*; but you must observe that your Colours are *thoroughly dry* before they are *exposed*. The several Colours I shall describe hereafter.

N. B. The *above Method* of making the *drying Oil* has one Inconvenience in it, that it makes the Oil of a *deep reddish Colour*, which in some Cases may alter the *Nature and Beauty* of some Colours, as *Whites*, which are liable to become *Yellow*; also  
*Blues*

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*Blues* may by this Means become *greenish*; to prevent which, *in the preparing of your Oil*, instead of *Red Lead* use *Letharge of Gold*.

*Of Colours used in Painting Sun-Dials.*

The Colours generally used in Painting Sun Dials are:

For *White*, Ceruse and White Lead.

For *Black*, Lamp-Black, Ivory-Black, Charcoal, and Sea Coal-Black.

For *Red*, Red-Lead, Vermilion and Cinnabar Lak.

For *Green*, Verdigrease.

For *Blue*, Indigo, blue Bice, blue Verditer and Smalt.

For *Yellow*, yellow Oker, and yellow Pink.

For *Brown*, Spanish Brown.

With the above Colours you may *compound* Variety of other Colours, *viz.*

An *Asb Colour* is made by mixing a *little* Lamp-Black with White.

A *Purple* is made by mixing Cinnabar Lak and blue Bice.

A *Carnation* is made by mixing Cinnabar Lak and White.

A *Green* is made by mixing blue Bice with yellow Pink. N.B. Any Blue and Yellow make a *Green* of some Degree or other.

A *Light Blue* is made by mixing blue Bice and White.

A *Lead Colour* is made by mixing Indigo with White.

A lively *Grass Green* is made by mixing Verdigrease with yellow Pink.

And by this Means may several other Colours be compounded and made *lighter* or *darker* at Pleasure, as a little Practice will make evident.



*How to prepare the Colours for painting Sun-Dials.*

Before you proceed to the painting of Sun-Dials in their several Colours, it is first necessary that they be *primed*, that is, painted *two* or *three* Times over with Oil, and Colour prepared for that Purpose, to fill up the Cavities which may (after plaining) remain in the Wood, and to make it perfectly plain, and the more capable to receive and retain other Colours; and of all priming *Spanish Brown* is reckoned to be the chief; for, not to mention its Cheapness, it *dries kindly*, and gives the Oil a sufficient Time to penetrate into the Wood: and consequently both resists the Weather, and also freely receives all other Colours which are laid upon it: it is of itself of a *Horse-flesh Colour*, and (besides its Usefulness in priming) is a *natural Shadow* for *Vermilion*, and may be made lighter or darker, according to the greater or less Quantity of *White* mixed with it; though in priming, it requires not any Mixture, but only the Oil itself.

In *preparing* the *Spanish Brown* for priming, grind it very well with the afore-mentioned *drying Oil*, and make it for the *first priming* somewhat *thinner* than you would do it for painting, that it may more easily penetrate into the Wood; which being dry, do it over a *second Time* with the same Mixture, only mix it a *little thicker*; and letting that dry, do it a *third Time*, mixing your Colour *thicker* every Time; and take care in the priming, not only to rub the Brush with the Priming all over the Plane, both on the *Back*, as well as on the *Fore-side* and *Edges*, the better to preserve it, but also to *bob* it against it, that the Priming may be sure to pierce into all the Cavities or Pores of the Wood:

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Wood: when this last Time of colouring with your Priming is dry, then colour the *Face* of the Plane over with *white Lead*, and when it is dry do it over again *three* or *four Times* more successively, after each drying; and so will the *Face* of your Plane be of a beautiful white Colour, and it will also be sufficiently defended against the Fury and Violence of the *Weather* for many Years; when the last colouring of your white is dry, your Plane is ready for laying on the Colours, *viz.* painting the *Hour Lines*, or what *Ornament* or *Furniture* you think fit to have upon it.

OBSERVE as a general Rule, that priming is to be mixed or tempered *thin*, but Colours for Lines or Figures to endure the Weather, must be tempered *thicker*, the better to resist the Fury of stormy or moist Weather.

*If you are only for making a common Sun Dial, these four Sorts of Colours will be sufficient.*

1. *Spanish Brown*; which prepare, and therewith *prime* your Dial, as before directed.

2. *White Lead*, well ground in Oil; with which, after the Priming is *thoroughly dry*, go over it three or four Times, letting it dry between every Time; which not only makes a beautiful white ground, but fortifies it yet more against the Fury of the Weather.

3. *Lamp-Black*, for drawing the *Hour Lines* and *Figures*.

4. *Vermilion*, for drawing the *Parallels of Declination*, or what other *Furniture* you think fit to put upon it.

The *Spanish Brown*, *Lamp-Black* and *Vermilion*, are all to be ground in the *drying Oil*, described in Page 132; and for the *White Lead*, it is to be used in the same Manner; only in making *drying Oil*

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For *White Lead*, instead of *Red Lead*, use *Litharge of Gold*, and proceed as before.

But if you would have your Dial more rich, you must first consider, what Colours you resolve to have your Lines, Figures, &c. to be, and upon what Ground your determined Colours will appear most beautiful. As,

1. *Gold* appears best upon a *Blue* ground, and indifferently upon a *Red*.

2. *Blue* and *Green* appear best upon *Yellow* and *White*.

3. *Red* sets off with *Yellow*, *White*, *Blue*, or *Green*.

4. *Yellow* sets off with *Black*, *Blue*, and *Red*.

Besides the Directions given already for *preparing* and *laying on* common Colours, it will be necessary to speak of the *laying on* the more rich and beautiful Colours; and first of *Gold*.

*How to make Gold Size, with which you design to lay on Leaf Gold.*

Take *yellow Oker*, and grind it with *Water* on a Stone with a Muller, till it be *very fine*, and then lay it *to dry*, and grind it with the afore-mentioned *drying Oil*, as you would grind other Colours, observing to put so much of each, that it may be of a *competent Stiffness* to work well, and of such a Body, that it may settle itself smooth when laid on, but not *so thin* as to run; and take care to grind it *very fine*, and it will add the greater Beauty to your *Gold* that is to be laid on with it.

*How*



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*How to lay Leaf-Gold on an Oily Size: or to make any Lines, Figures, &c. of Leaf Gold upon your Dial.*

Draw your Lines, Figures, or Letters, or what you think fit to have in Gold, with *Gold Size*, (abovementioned;) which dry so, that when you touch it with your Finger it will *stick a little* to it, but the Colour not *come off*; for if the Colour *comes off* on the Finger, then it is not dry enough, and must be let alone a little longer; for if you should then lay the Gold on, it would drown it so that it would be worth nothing; and on the other Hand if the Size should be so dry as to hold your Finger, as it were, to it, then is it too dry, and the Gold will not take, for which there is no Remedy but new sizing: therefore you must watch that it be not too wet or too dry. Then cut your Leaf Gold as near as you can, into the Form you would have it, whether of Figures, Letters, Lines, &c. (taking care to cut it rather *too large* than *too little*;) and with a flat Stick lined with woollen Cloth, first rubbing it on your Cheek, or breathing on it, take up your Gold (so cut) and put it upon the Size, and the Gold will leave your lined Stick, and cleave to the Size; then *press it down* with *Cotton*, or *Hare's Foot*, and take care that you make the Figures, Lines, or Letters, in the *Gold Size*; and that you cut the Gold *large enough* to cover the Figures so made in the Size; and when it is *thoroughly dry*, brush off the loose Gold, and the painting will remain beautiful, and be able to endure the Weather.

*Note further*, That a Book of Gold contains 25 Leaves, each Leaf being three Inches square; the Price of each Book is Two Shillings at the Gold-Beater's; one Book will cover 225 square Inches of Work; for so many square Inches are contained in 25 Leaves, that are three Inches square, every Leaf containing nine square Inches superficial in Gold. The right Understanding of this will much guide you in judging how many Books of Gold will serve to gild that Work, whose superficial Contents in square Inches may before-hand be known.

*How to lay on Smalt to make a fine Blue.*

When you have laid on what you think fit in *Leaf Gold*, take *white Lead*, mix it *pretty stiff* with *drying Oil*, and with a Pencil lay that on where you intend your *Blue* shall be, and then put your *Smalt* in a *fine Searce*, and sift it on to the Dial, and with a *Piece of Cotton* dab it down upon the *White* before laid on, and when it is *thoroughly dry*, wipe off all the loose Colour with a *Feather*, and blow off the Dust with a *Pair of Bellows*, which will easily blow off all, except what fell upon the *White* before laid on to retain the *Blue*, which will be a very beautiful Blue.

*Of the Nature and Colour of some of the principal Ingredients used in painting of Sun Dials.*

1. CERUSE and *White Lead* are the only Colours to be used in painting in Oil, and besides their Usefulness in painting of Dials, Paint made up with them and Oil, is frequently made use of in painting Posts, Palisadoes, Gates, Doors, Windows, Waincoting, &c. and answers the End of Painting, both as to Beauty and Preservation, for they dry well, and strongly resist the Weather; and if you would have them *to dry yet more speedily*, you may in the *tempering* put a little *Oil of Turpentine*, if it be *within Doors*; but *without Doors*, it is better without, because that does not so well resist the Weather.

2. *Lamp-Black* is a good Black, if it be first burnt, then ground, and lastly tempered with Oil.

3. *Charcoal* is a Black that will serve for ordinary Uses; it *dries well*, but great Care must be taken that it be *well ground*.

4. *Spanish Brown*; the best is a *deep bright Colour*,

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*lour*, and free from Stones, and being very well ground, is the best for priming: It is of a *Horse Flesh Colour*, and a *proper Shadow* for *Vermilion*.

5. *Red Lead* is a great *Drier* and *Binder*; for which Reason, it is made use of in the *drying Oil*; it resists the Weather as well as any Colour whatsoever.

6. *Vermilion* is a rich Colour, and of a good Body, but Care must be taken that it be finely ground, *even as soft as Oil*, and then it will work extraordinary well: It is best to buy it *in the Stone*, lest you meet with some that has been *adulterated* with *Red Lead*, or the like; it is a perfect Scarlet of itself, and may be altered to several Varieties, by mixing with other Colours.

7. *Cinnabar Lak* is a rich *Crimson* Colour, and must be very fine ground.

8. *Smalt* is a very *fine Blue*, and it is best to be *strewed* on, as before taught; for if you work it *in Oil*, (though you wash it and mix it with *White Lead*) yet it will *turn black in Time*; if you buy it *to work in Oil*, the *finest* is best, which is called *Oil-Smalt*.

9. *Blue Bice* is a *pale Colour*, and works well though a little sandy.

10. *Blue Verditer* is not so good a Blue as *Bice* and *Smalt*, though it may serve in Dial-painting where they are wanting; but it is a little sandy, and apt to *fade* and *turn greenish*.

11. *Indigo* is a very *dark Blue*, and commonly lightened with *White*, when used in Painting, except in Shadowing; it grinds fine, and is very proper for the *last Colour* of Posts, Palisadoes, Doors, Windows, &c. for it resists the Weather, and preserves the Wood.

12. *Blue Balls* are almost like *Indigo*, but not so good a Colour, nor will it endure so long.



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13. *Umber* is a *Hair-Colour*, it must be very finely ground, which to effect, requires a great deal of Labour; it *dries* and *binds* exceedingly, and is therefore also very proper for painting without Doors, as Doors, Palisadoes; if calcined in a *Crucible*, it is a *natural Shadow* for *Gold*, and some other Colours.

14. *Verdigrease* is a perfect *willow green*, but may be altered at Discretion, with *Yellow*, &c. but being *very foul*, it must be mended or cleansed, which may be thus done: *Grind it fine, and put to it eight Times its Weight of Spirit of Vinegar, digest till the Vinegar is tinged very green, then decant the Colour; cast away the Faces, and evaporate the Vinegar in a Brass Vesica, so have you a very good Verdigrease at the Bottom, much more fine and valuable, than before it was cleansed; it dries very speedily.*

15. *Yellow Oker*, the *English*, the Colour of *fresh Wheat Straw*; the foreign is of somewhat a *more deep Colour*; it is much used in common Painting, being ground very fine.

16. *Yellow Pink* is a *greenish Yellow*; it grinds well, and is good to mix with other Colours to make a *Green*.

Of these Colours some require *washing*, as *Red Lead*, *Blue Bice*, *Smalt* and *Verditer*, which is thus performed.

Put the Colour into a glazed Vessel, and put thereto plenty of clear Water, wash it well, and (after a while) *decant* the Water; repeat this Work *six* or *seven* Times; at last (the Water being but just troubled) put it into another glazed Vessel, leaving the Dregs at the Bottom; then put some more Water into this second Vessel, and wash it as before, till the Water after settling be clear, and the Colour remain fine at the Bottom.

*Note,*

## Ch. XXVI. Of Painting Sun Dials, &c. 141

*Note*, Before you take the Colour out of the Vessel, *spread it* about the Sides of the Vessel *very thin*; and when it is dry, it will Part of it fall down to the Bottom, which keep by itself, but that which sticks to the Sides of the Vessel is the best, and is as fine as any Flower; that strike off with a Feather, and keep it for Use.

The Colours that require *washing* being thus prepared, (or if they are those that do not require washing, they are done without) your next Work is to *grind them*, which is done thus:

Take a Spoonful or *two* of the Colour you intend to grind, and put to it a little *linseed Oil*, (but be careful you put in too little rather than too much;) mix them together, and upon your Stone with a Muller, grind them well, adding Oil *by Degrees*, as you see it requires it, to make it like an Ointment, (always observing that it grinds much better when it is *thick*, than when it is *so thin*, as to run about the Stone;) every now and then scrape it up together with a *thin Knife* or *Lanthorn-Horn* to keep it at, or near the Middle of the Stone, and so continue to work till you have ground as much as you have Occasion for; which done, clean your Stone by grinding *Sand* and *Water* upon it, and then wash and dry it, and the Muller; and when you go to make use of it, mix it with *drying Oil*, till it be so thin as to *run freely* from the Pencil, yet so thick that the Ground may not *appear through* it, or to *run* when it is laid on, and then it will be the more beautiful Colour, and better endure the Weather.

*Note*, Dials are not to be refreshed but by new painting; yet here take notice, that I think it not convenient at all to lay new Colouring upon the old Ground of a *Sun-Dial* (that is, to draw the old Lines and Figures over again in the same Posture, wherein they were drawn before) but rather to take the Declination a-new, and according

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ing thereunto make a *new* Draught of your Dial, and proceed in the painting of it, in all Respects, as if it were a new Dial; for it is observed, that Dials which were made many Years, as 30 or 40 Years ago (which we believe went true when first made) will not give the true Hour now, but go very false, which is caused by some secret Motion of the Earth, not hitherto taken Notice of, which apparently alters the Declination of all *Planes* whatsoever. If any one requires more Satisfaction herein, let him repair to some old Dial that was made many Years ago, and according to the Distance of the Substile from the Meridian, let him find out the Declination when first made, as any Man that is an Artist can easily do; then let him take the Declination of the Plane by the Sun, and he shall find these two Declinations to differ considerably, according to the number of Years contained between your Observation, and the Time of the Dial's first Making: So that a Plane that stood full South 30, 40, or 60 Years ago, shall now decline some Degrees either to the East or West, according to the nature of the Earth's Motion, which is that which is called the *Variation of the Compass*, which is found by Observation to differ much in the same Country, in the Space of 50 or 60 Years, as all skilled in Astronomy very well know.

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### CHAP. XXVII. *The Manner of Painting* Timber Work.

**B**y *Timber Work* I mean all Manner of Wainscot, Doors, Windows, Posts, Rails, Pails, Gates, Border-boards for Gardens, &c. to preserve them from the Violence of Rain or Injury of the Weather; the Method of doing which, I shall here lay down as plain as I can.

Suppose then that there be a Set of *Palisadoes*, or a *Pair of Gates*, or some *Posts* and *Rails* to paint, and I would finish them in a *Stone Colour*; first look over the Work, and take notice whether the Joints be open in the Gates, or whether there be any large *Clefts* in the Posts; for if these are not secured, the *wet* will insinuate itself into those Defects, and make the quicker Dispatch in rotting the whole Work: let the first Business therefore be to stop up these  
Places



## Ch.XXVII. *Of Painting* Timber Work. 143

Places smooth and even with *Putty*, which is made of Whiting and Linseed Oil, well beaten together on the grinding Stone, or with a wooden Mallet, to the Consistence of a very stiff Dough, and with this let all the Crannies, Clefts, and other Defects be perfectly filled up, that it may be *equal* to the Surface or Outside of the Stuff; then proceed to the priming of the Work with some *Spanish Brown* well ground and mixed very thin with Linseed Oil; with this do over the Work, giving it as much Oil as it will drink up; this in about *two* Days will be indifferently dry: then, if you would do the Work substantially, do it over again with the same priming Colour; when it is thoroughly dry, then take White Lead well ground and tempered up, but not *too thin*, for the *stiffer* you work it, if it be not too stiff, the better Body will be laid on; and the longer it will last: let the Colour be well rubbed on with a large Bristle Brush, and the whole Surface of the Work be so entirely covered, that there remain no Crack nor Corner bare, which you may easily do by *jobbing* in the Point of a Bristle Brush: Let this first Colouring dry, and then go over it a *second Time*, and if you please a *third* also: the Charge will be a little more, but the Advantage will be great in the Duration. This Course is sufficient for any Kind of *Timber Work* that requires only a plain Colour, whether you thus cover the Work with a *Stone Colour*, or else with a *Timber Colour* in Umber and White, or a *Lead Colour* with Indigo and White, that with White being cheapest of the three by much: nay I have known some lay over their Work only with a Coat of *Spanish Brown*, by tempering it up more stiff than was done for the two first Primings, which in some Respects is cheapest of all,

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all, and preserves the Timber perhaps as well as any. Now he that is able to bring the Work thus far on, has proceeded to the highest Pitch of that vulgar Painting, that aims at Preservation beyond Beauty, though something of Beauty is necessarily included in this also; but this is not all, for he that is arrived thus far, is in a fair Way to other Perfections in the Art of Painting; but for the Painting of *Wainscot* with its proper Shadows, and for imitating *Olive* and *Walnut Wood*, *Marbles*, and such like, these must be attained to by ocular Inspection; it being impossible to deliver the Manner of the Operation by Precept without Example; and I am bold to affirm, that a Man shall gain more Knowledge by one Day's Experience, than by an Hundred spent to acquire it some other Way.

I advise therefore all those that desire an Insight into this Business, to be a little curious, if Opportunity offers, in observing the Manner of a Painter's working, not only in grinding his Colours, but also in laying them on, and working in them, in all these observing the Motion of his Hand, in the manage of any Kind of Tool, and by this Means, with a little Imitation joined to the Directions here given, I doubt not but in a short Time you may arrive to great Proficiency in the Business of vulgar Painting.

*Note*, That if when you have made use of your Colours, there be occasion for a small Cessation till the Work be finished, in this Case it is best to cover the Colours, if any remain in your Pots, with *Water*, for that will prevent their *drying*, even in the hottest Time.

And for your Pencils, they ought, so soon as you have done working, to be well washed out in clean Linseed Oil, and then in warm Soap-Suds; for if  
either

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either Oil or Colours be once dried in the Brush or Pencil, it is spoiled for ever.

It has been observed, that Timber laid over with *White*, when it has stood some Time in the Weather, the Colour will *crack* and *shrink* up together, just as Pitch does, if laid on any Thing that stands in the Sun; the Cause of this is the Colour's being laid on with *too stiff a Body*, for being wrought *too thick* once, it will dry with a *Skin on the Outside*, which will keep the *Inside* moist and prevent its binding firm, from whence those Cracks proceed.

*Take notice*, that if you shall at any Time have occasion to use either Brushes that are very small, or Pencils, as in many Cases there will be occasion, you ought then to dispose of the Colours you use upon a *Pallet*, (which is a wooden Instrument easy to be had at any *Colour Shop*;) and there work and temper them about with your Pencil, that the Pencil may carry away the more Colour; for *you are to note*, that if a Pencil be only dipt into a Pot of Colour, it brings out no more with it than what hangs on the *Outside*, and that will work but a little Way, whereas if you rub the Pencil about in the Colour, on a Pallet, a good Quantity of Colour will be taken up in the *Body of the Pencil*; and besides all this, you may work your Pencils better to a Point on a Pallet, than you can do in a Pot; the Point of a Pencil being of greatest Use in divers Cases, especially in drawing of Lines, and all kind of Flourishing.

I shall still be more particular under this Head of Painting, because Painters Work is very expensive, and is the only Part in Building wherein a Gentleman can be assisting either by himself or Servants, it being almost impossible for any Gentleman to do either Masons, Bricklayers, Carpenters, or Smith's Works,

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whereas



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whereas it is now well known and experienced, that since the Advertisement of *Alexander Emerton*, several Noblemen and Gentlemen have by themselves and Servants painted whole Houses without the Assistance or Direction of a Painter, which when examined by the best Judges could not be distinguished from the Work of a professed Painter.

And that which conduces most to this Practice is the vast Disproportion between the Prices which Painters charge for their Work, and the Expence which Gentlemen are at in this Method of Painting, which at the utmost doth not amount to *one fourth* Part of the Painter's Price, to prove which I shall set down the Prices of Colours, and likewise shew what *Number of Yards* one Pound of each Colour will paint.

*First Primer* ground in Oil, at 36s. *per* 112lb. weight, or 4d. *per* lb. One Pound of which will paint 20 *square Yards*.

*Second Primer* ground in Oil, at 36s. *per* 112lb. weight, or 4d. *per* lb. One Pound of which will paint 12 *square Yards*.

*Best White Lead* ground in Oil, at 36s. *per* 112lb. or 4d. *per* lb. One Pound of which, with two pennyworth of Oil, will paint 8 square Yards, which is three Farthings *per* Yard, for which Painters usually charge 4d. *per* Yard.

1. *Pearl Colour* ground in Oil, at 4d. and 5d. *per* lb.
2. *Lead Colour* ground in Oil, at 4d. and 5d. *per* lb.
3. *Cream Colour* ground in Oil, at 4d. and 5d. *per* lb.
4. *Stone Colour* ground in Oil, at 4d. and 5d. *per* lb.
5. *Wainscot*, or *Oak Colour* ground in Oil, at 4d. and 5d. *per* lb.

N. B. One Pound of any of these five Colours, with Oil, will paint eight square Yards, for which Painters usually charge 4d. *per* Yard.

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1. *Chocolate Colour* ground in Oil, at 6d. per lb.
2. *Mahogany Colour* ground in Oil, at 6d. per lb.
3. *Cedar Colour* ground in Oil, at 6d. per lb.
4. *Walnut-tree Colour* ground in Oil, at 6d. per lb.

N. B. One Pound of any of these four Colours with Oil, will paint 10 square Yards, for some of which Painters usually charge 4d. per Yard, for others more.

1. *Gold Colour* ground in Oil at 8d. per lb.
2. *Olive Colour* ground in Oil from 8d. to 12d. per lb.
3. *Pea Colour* ground in Oil from 8d. to 12d. per lb.
4. *Fine Sky Blue* mixed with *Prussian Blue* ground in Oil from 8d. to 12d. per lb.
5. *Orange Colour* ground in Oil at 12d. per lb.
6. *Lemon Colour* ground in Oil at 12d. per lb.
7. *Straw Colour* ground in Oil at 12d. per lb.
8. *Pink Colour* ground in Oil at 12d. per lb.
9. *Blossom Colour* ground in Oil at 12d. per lb.

N. B. One Pound of any of these nine Colours with Oil, will paint eight square Yards, for some of which Painters usually charge 10d. or 12d. per Yard, for others they will expect more.

*Fine deep Green* ground in Oil at 2s. 6d. per lb.

N. B. One Pound of which with Oil, will paint 20 square Yards, for which Painters usually charge 12d. per Yard.

*Oils used in House-painting are,*

1. *Linseed Oil* at 10d. per Quart.
2. *Turpentine Oil* at 12d. per Quart.
3. *Best drying Oil* at 12d. per Quart.

*Painting*

## *Of Painting Timber Work.* Ch. XXVII.

*Painting Bruskes* of several Sizes from 2*d.* to 6*d.* each.

*Putty* at 4*d.* per lb.

*Double Size* used by the Painters for priming new Work at 4*s.* per Firkin, or 2*d.* per Quart.

*Single Size* at 18*d.* per Firkin, or 1*d.* per Quart.

These Colours, with all other Materials used in Painting, are prepared in the best Manner, and sold by ALEXANDER FLEMINGTON, Colourman, at the Bell, over-against Arundel-Street, near Saint Clement's Church, in the Strand, London. He likewise gives printed Directions for the using of his Colours, or procures Painters to work for Gentlemen by the Day, if required.

I. Blackwell

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